AI

AUTOMOTIVE INDUSTRIES

AUTOMOTIVE and AVIATION MANUFACTURING
ENGINEERING • PRODUCTION • MANAGEMENT

JANUARY 1, 1958

THE CHALLENGE OF SOVIET INDUSTRY

What Progress Is Russia Making? What Are Her Strengths and Weaknesses? These and Other Questions Are Discussed Here in This Special Series of Analytical and Interpretative Reports on Soviet Industrialization. Their Authors Are Among the Foremost Authorities in This Country on the Soviet Economy

INDUSTRIES • MANPOWER • ENERGY • MACHINERY • MOTOR VEHICLES • TRANSPORTATION

ADDED FEATURE—RUSSIA'S MISSILE PROGRAM

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AUTOMOTIVE INDUSTRIES

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JANUARY 1, 1958 — VOL. 118, NO. 1

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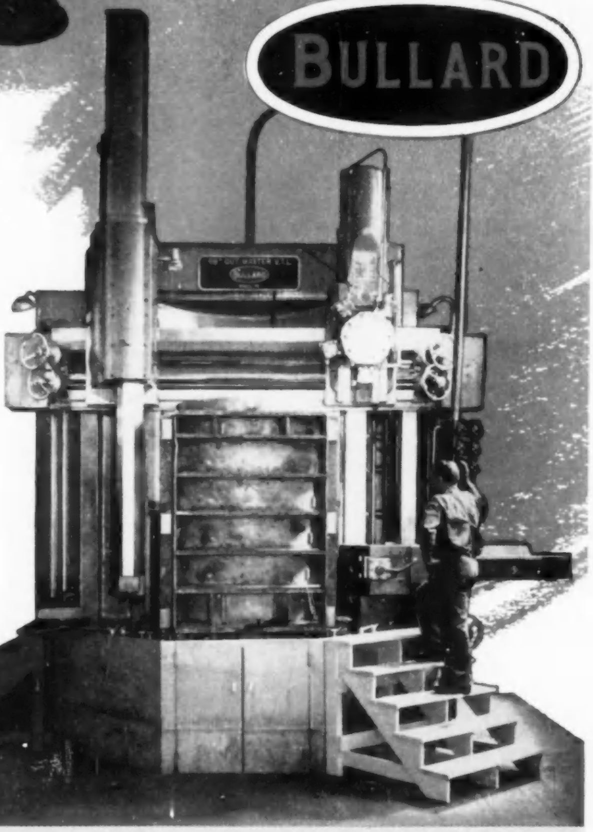
are You interested in

PROFIT DEVELOPMENT

through reduced machining time *and Lower Costs . . .*



The new 66" Bullard Cut Master, Model 75 purchased by E.D. Jones & Sons Co., Pittsfield, Mass., has reduced from 65 to 48 hours the machining time required for a 4,000 lb. stainless steel piece used in a paper-making machine.

The Bullard Cut Master V.T.L., Model 75 line offers many features and advantages to help you — cut costs when cutting metal.

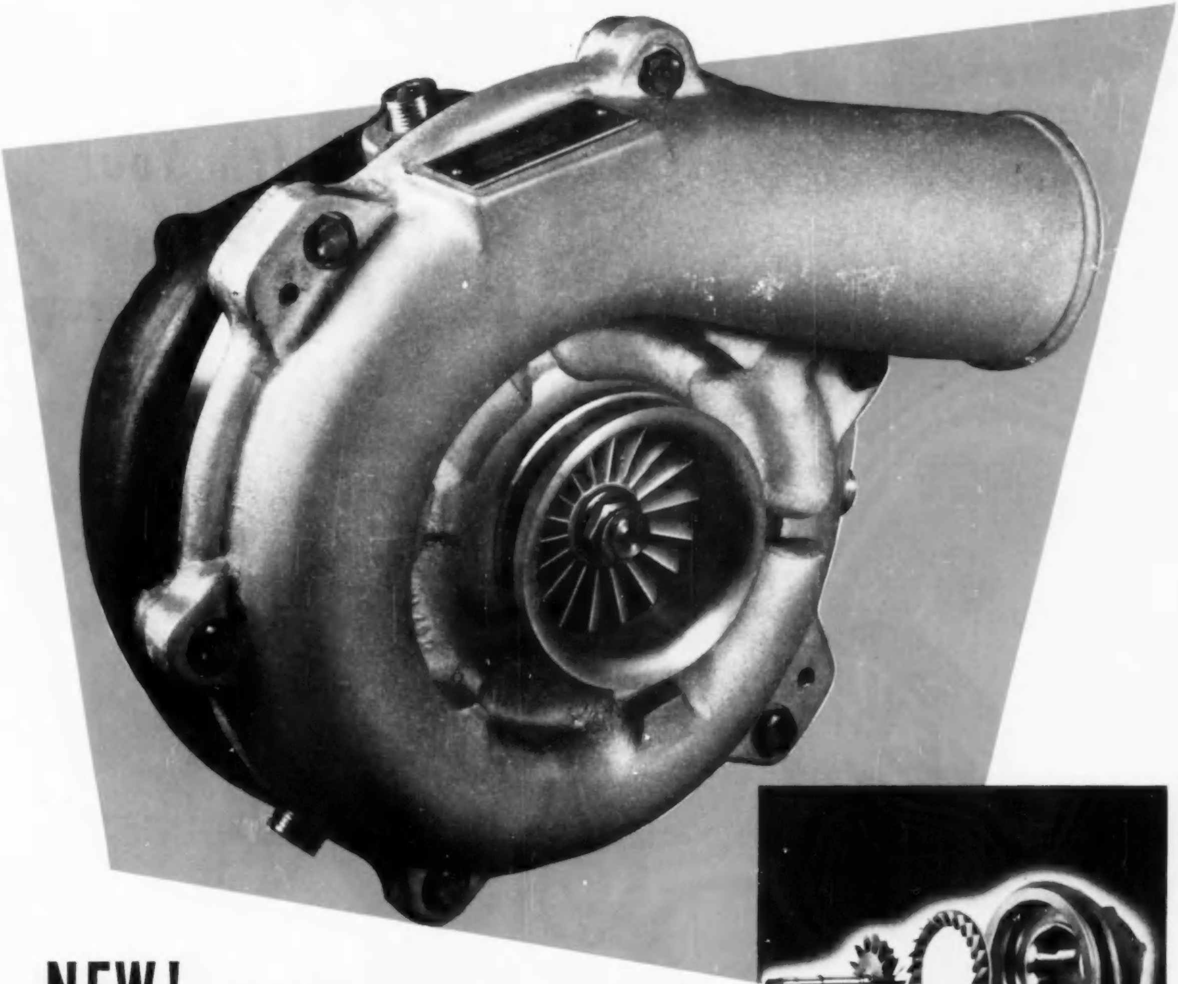
The part, 68" high, formerly had to be machined in three operations. Now, with an extension on the 62" Ram, a table speed of 9.6 r.p.m., feed of .0208 and ⅛" depth of cut, it is possible to machine the entire depth in one operation.

Close-up showing step boring and facing operation with 370 grade carboloy tool.

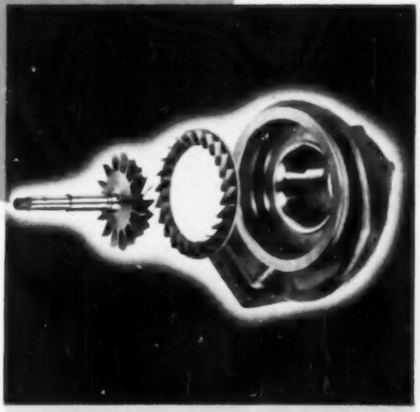
Complete details are available from your nearest Bullard Sales Office or Distributor or write

THE BULLARD COMPANY

BRIDGEPORT 9, CONNECTICUT



NEW! Prompt response to speed and load changes with Thompson Turbocharger



Moving parts in the new-design Thompson Turbocharger for diesel engines are made of light alloys to reduce inertia to speed changes. Response of the Thompson Turbocharger to variations in engine speed and air requirements is almost instantaneous . . . no ragged engine performance due to lag in blowing.

The light alloy impeller also permits bearings to be simpler in design. Shafts can be smaller in diameter to reduce bearing surface speeds and increase bearing life.

Other advantages of the new Thompson design include: straight-bladed impeller for high pressure ratios over wide range of air flow, new-design diffuser for peak performance over wider operating range, and unique design to isolate exhaust heat from bearings and air-side of Turbocharger.

Your diesel engines up to 300 horsepower can readily be equipped with Thompson Turbochargers . . . the most modern design available. A Jet Division engineer will call at your convenience to work with your engineers.

Write today on your company letterhead for Booklet AI-158, which contains technical data on Thompson Turbochargers for blown diesel engines up to 300 horsepower.

JET DIVISION

Thompson Products, Inc.

Cleveland 17, Ohio

GREENLEE TRANSFER MACHINES

Change with Your Requirements

THIS MACHINE HAS BEEN REWORKED FOUR TIMES

The "building block" idea of machine tool design has gained much popularity in recent years. Greenlee has long built such flexibility into their transfer machines. For example, the machine shown here has been modified 4 times in 11 years to accommodate changes in product design. Protect yourself from costly obsolescence. Ask Greenlee to show you how.

PHONE ROCKFORD, ILLINOIS 3-4881
TO HELP SOLVE YOUR PRODUCTION PROBLEMS

GREENLEE
BROS. & CO.

1751 MASON AVE.
ROCKFORD, ILLINOIS

XXV

This is the twenty-fifth of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

Thermal Stress-Relieving of Alloy Steels

In the production of alloy steel bars and parts made of alloy steel, stresses are sometimes set up, and these stresses must be relieved before optimum results can be expected. Two general types of stress-relieving are practiced—thermal and mechanical. In this discussion we shall consider only the former.

There are several important reasons for thermal stress-relieving. Among these are the following:

(1) The first and most fundamental purpose is to reduce residual stresses that might prove harmful in actual service. In the production of quenched and tempered alloy steel bars, machine-straightening is necessary. This induces residual stresses in varying degrees. Bars are usually stress-relieved after the straightening operation. When the bars are subjected to later processing that sets up additional stresses, subsequent stress-relieving may be necessary.

(2) A second major purpose of thermal stress-relieving is to improve the dimensional stability of parts requiring close tolerances. For example, in rough-machining, residual stresses are sometimes introduced, and these should be relieved if dimensional stability is to be assured during the finish-machining.

(3) Thermal stress-relieving is also recommended as a means of restoring mechanical properties (especially ductility) after certain types of cold-working. Moreover, it is required by the "safe-welding" grades of alloy steels after a welding operation has been completed.

Alloy bars are commonly stress-relieved in furnaces. Temperatures under the transformation range are employed, and they are usually in the area from 850 deg to 1200 deg F. The amount of time required in the furnace will vary, being influenced by grade of steel, magnitude of residual stresses caused by prior processing, and mass effect of steel being heated. After the bars have been removed from the furnace, they are allowed to cool in still air to room temperature.

In the case of quenched and tempered alloy bars, the stress-relieving temperature should be about 100 deg F less than the tempering temperature. Should the stress-relieving temperature exceed the tempering temperature, the mechanical properties will be altered.

Items other than bars (parts, for example) can be wholly or selectively stress-relieved. If the furnace method is used, the entire piece is of course subjected to the heat; selective relieving is impossible. However, if a liquid salt bath or induction heating is used, the piece can be given overall relief or selective relief, whichever is desired.

Detailed information about stress-relieving is available at all times through Bethlehem's technical staff. Feel free to consult with our metallurgists, who will cooperate fully without cost or obligation on your part. And remember that Bethlehem can furnish the entire range of AISI standard alloy steels, as well as special-analysis steels and all carbon grades.

If you would like reprints of this series of advertisements from No. I through No. XX, please write to us, addressing your request to Publications Department, Bethlehem Steel Company, Bethlehem, Pa. The first 20 subjects in the series are now available in a handy 36-page booklet, and we shall be glad to send you a free copy.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

HILL GRINDING AND POLISHING MACHINES

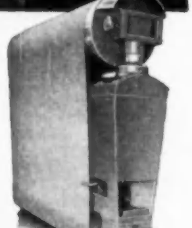
For FINISHING

Any and All

FERROUS and NON-FERROUS MATERIALS . . .

HILL Polishing Machine
(Hydraulic Table Type)
For polishing individual sheets and plates. Hydraulic reciprocating table with centralized controls.

The basic HILL two-roll vertical head with upper steel idler roll and lower rubber covered contact or work roll (both dynamically balanced) over which the endless abrasive belt travels.



FLAT surfaces of ferrous or non-ferrous material can be brought quickly to the high finish so necessary for today's industrial and consumer products. The dairy, automotive, home appliance and engraving industries are typical of the wide range of application for these precise, labor saving machines.

HILL abrasive belt grinding and polishing machines are built in two general types. The hydraulic reciprocating table type polished individual sheets and plates. Table widths vary from 36″ to 60″. Table lengths range from 60″ to 240″. The Pinch-Roll type is for progressive line polishing. The HILL two-roll vertical head with endless abrasive belt is the basic principle common to both types.

When writing for information please indicate size and specifications of stock to be finished.

HILL Grinding and Polishing Machine
(Pinch-roll Type)
For pre-finishing, conditioning and polishing. Used as single units or in multiple units for progressive line polishing in wet or dry operations.

HILL ACME TOOLS FOR INDUSTRY

THE HILL ACME COMPANY

HILL DIVISION
ESTABLISHED 1882
1209 West 65th Street • Cleveland 2, Ohio

"HILL" GRINDING & POLISHING MACHINES • HYDRAULIC SURFACE GRINDERS • ALSO MANUFACTURERS OF "ACME" FORGING • THREADING • TAPPING MACHINES • "CANTON" ALLIGATOR SHEARS • BILLET SHEARS • "CLEVELAND" KNIVES • SHEAR BLADES

Something had to be done ...Sun has done it!

Miracle Sunoco Blending Pump solves the octane problems of all cars...for years to come!

Sunoco's miracle blending pump outmodes all existing 2- and 3-grade systems

The widening spread of octane requirements between the new and the older cars has created a major problem to millions of America's car owners. With conventional gasoline marketing systems they have been unable to obtain maximum performance without the penalty of paying for octane their cars don't need.

No two- or three-grade system, with wide gaps in octane quality and price jumps of 3¢ and 4¢ between grades, can meet the problem.

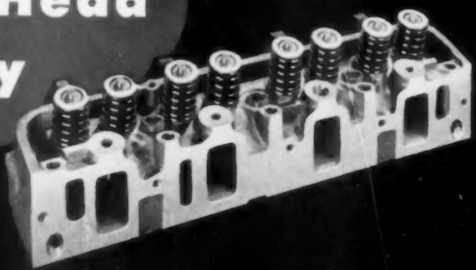
Only Sun—with its revolutionary new blending pump that blends 6 different octane grades—can guarantee every car, whatever the make or model, best performance at lowest cost per mile.

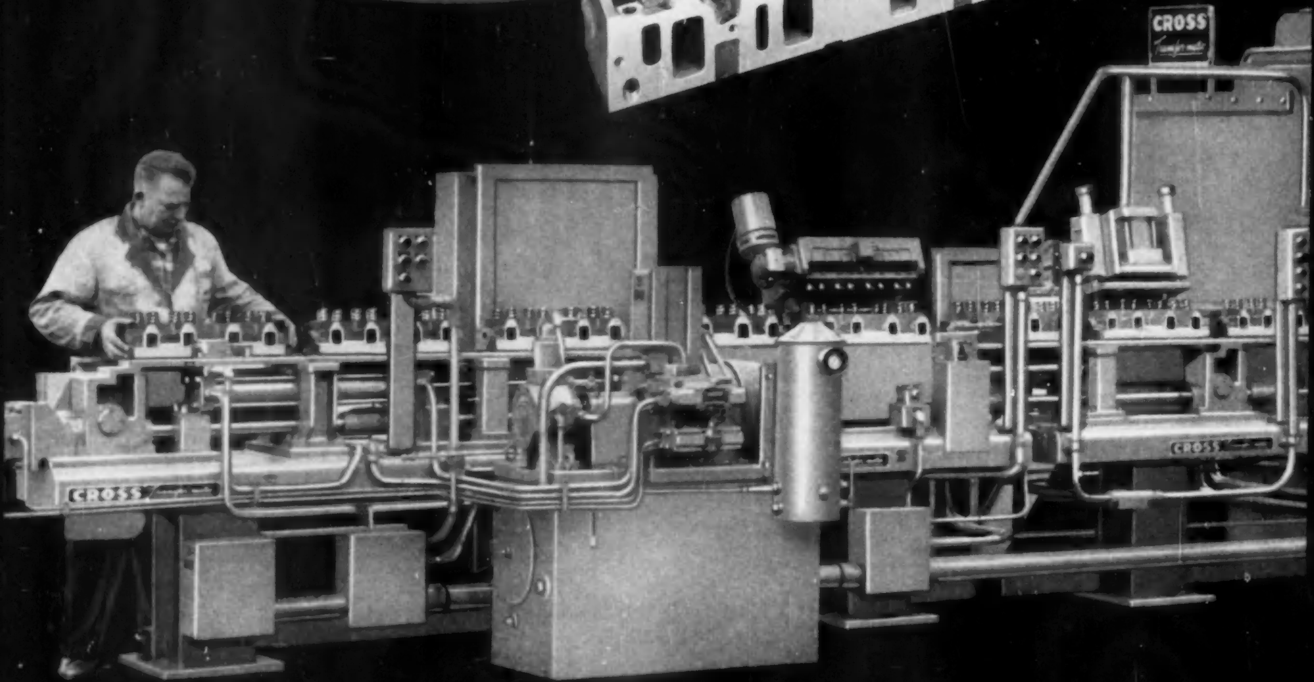
In 2 years of testing in Florida, it has changed the gasoline buying habits of thousands and thousands of motorists. Now Sun is extending its new system of custom-blended fuels throughout its entire marketing territory. An entirely new concept of marketing, it introduces a new era of motor fuel buying. It's the only complete answer to the octane problems of the cars of today and tomorrow.

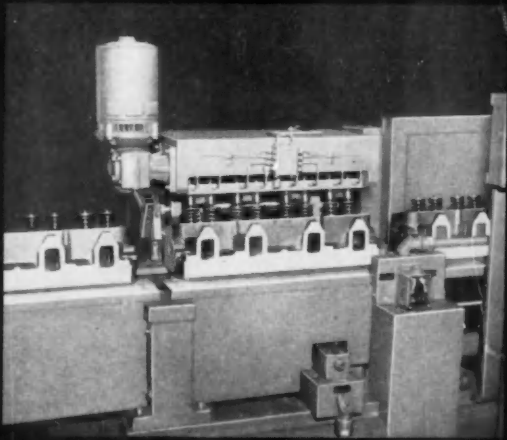
BLUE SUNOCO

Sun Oil Company, Philadelphia 3, Pa.

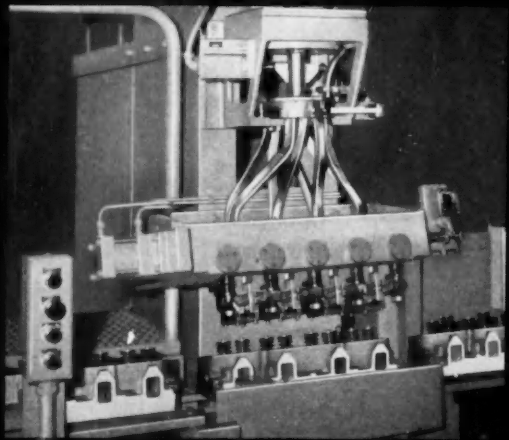
Automation for Cylinder Head Assembly







Station 25: Valve "popping".



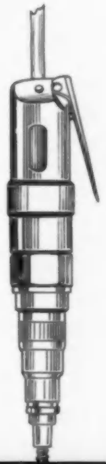
Station 17: Automatic assembling of valve locks.

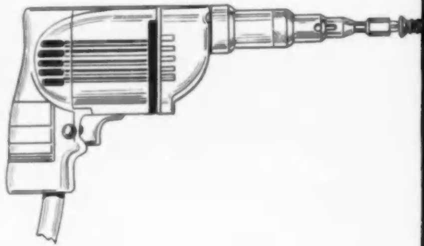
Continental sets quality standards to **make high-speed driving pay off** its full potential in savings

Are you "collecting" the savings you rightfully expect from the use of automatic screw driving machines and other power driving equipment? Most of the potential savings can be wasted when fastener faults cause frequent downtime on the assembly line.

That is why Continental quality-control standards are matched to the most exacting demands of high-speed driving equipment. Special tests and trial runs are used to spot any defects that might pass undetected in ordinary inspection. No screws that fail to meet Continental's close tolerances get by. You get dependable uniformity in every detail, and avoid slow-downs.

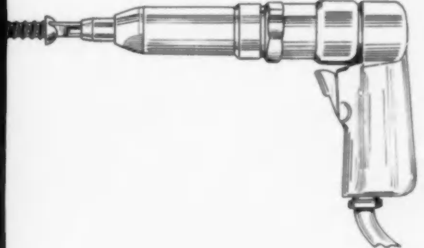
Next time you order fasteners, specify Continental HOLTITE. You'll see why Continental users "collect"—day after day—the *full savings* planned in assembly. For prompt service, write or phone: Continental Screw Co., 451 Mt. Pleasant St., New Bedford, Mass.

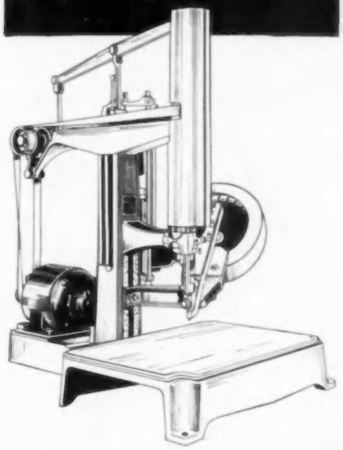




Here's where you win or lose on fastener costs.

Keep assemblies trouble-free.





Test runs duplicate assembly line conditions

Automatic screw driving machines of the types in current use are set up in the Continental quality-control laboratory as required for test runs under job conditions. With these and many other tests, Continental assures you of fastener quality and uniformity matched to the toughest high-speed driving demands.

Are you missing savings you could be making?

Find out how Continental specialized cost-saving experience can help you. At your request, a Continental Assembly Specialist will survey your operations, and make detailed recommendations for maximum cost reduction. This advice is unbiased, since HOLTITE Fasteners include all types of threaded fasteners.

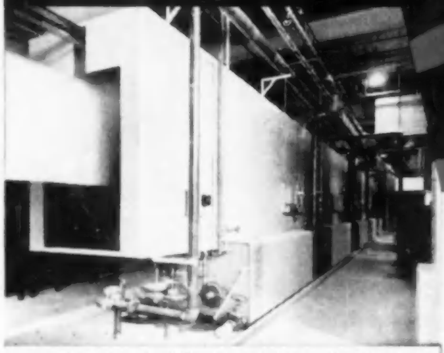
MEMBER
SCREW RESEARCH
ASSOCIATION

CONTINENTAL
HOLTITE FASTENERS

HOLTITE PHILLIPS AND SLOTTED HEAD
WOOD • MACHINE • TAPPING • THREAD-FORMING • SEMS • NYLOK
HY-PRO PHILLIPS INSERT BITS AND HOLDERS

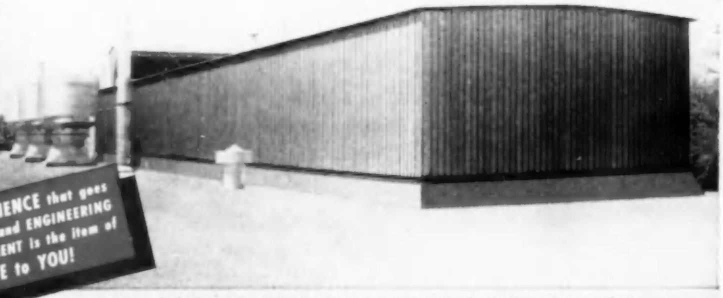
COMPLETE *Finishing* SYSTEMS

. . . for ENAMELS • LACQUER • PAINT • VARNISH



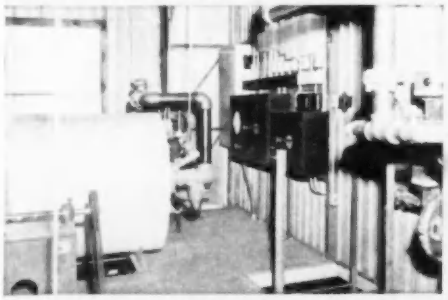
Mahon Five-Stage Metal Cleaning and Rust Proofing Machine—Part of the Complete New Mahon Finishing System at Hussmann.

Mahon Dry-Off Oven at Exit End of Cleaning and Rust Proofing Machine. Oven Controls are visible in the foreground.



Mahon Self-Housed Finish Baking Oven installed on the Roof of the Hussmann Refrigerator Co. Plant. Air Intake, Filtered Air Supply Equipment and Heaters are Housed at the far end.

48 Ft. Mahon Hydro-Filter Spray Booth in foreground. Another 24 Ft. Spray Booth for reverse side painting is visible in the background. Note Filtered Air Diffusers in the Ceiling.



Equipment Room between Finish Baking Oven and Air Supply Room. This room houses Heating Equipment and Controls for both Units.

Mahon Installs THIRD COMPLETE FINISHING SYSTEM in Hussmann Refrigerator Plant!

In addition to several smaller projects, the Mahon Company has installed three Complete Finishing Systems for the Hussmann Refrigerator Co., St. Louis, Mo. The latest one, illustrated here, was designed to paint steel shelving. It consists of a five-stage Metal Cleaning and Rust Proofing Machine, a Dry-Off Oven, two Hydro-Filter Spray Booths, an Air Conditioned Spray Room, and a Finish Baking Oven. The Cleaning and Rust Proofing Equipment, Dry-Off Oven and Spray Room are located inside the plant; the Filtered Air Supply Equipment and the Finish Baking Oven are housed on the roof. This is a typical Mahon Finishing System designed to occupy a minimum of floor space inside the plant, and to do a particular finishing job efficiently and economically. Repeat orders from customers over a period of years is an unquestionable expression of confidence in the Mahon organization, and it is an unspoken tribute to Mahon engineering, and to the quality and operating efficiency of Mahon equipment. If you have a finishing problem, or are contemplating new finishing equipment, you, too, will want to discuss methods, equipment requirements and possible production layouts with Mahon engineers . . . you'll find them better qualified to advise you, and better qualified to do the all-important planning, engineering and coordinating of equipment, which is the key to producing the finest finishes at minimum cost. See Sweet's Plant Engineering File for information, or write for Catalog A-658.

THE R. C. MAHON COMPANY • Detroit 34, Michigan

SALES-ENGINEERING OFFICES in DETROIT, NEW YORK and CHICAGO

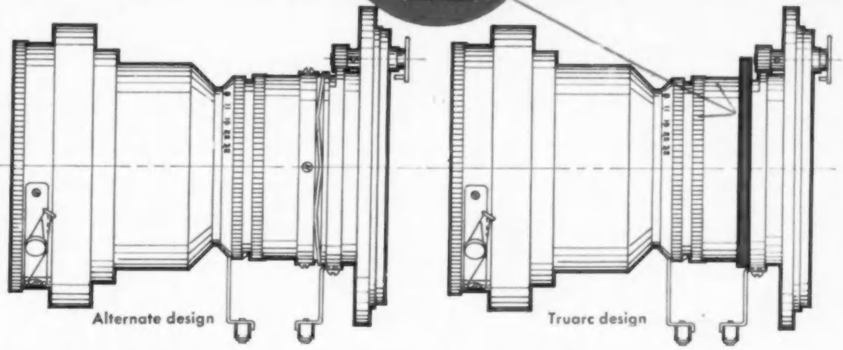
Engineers and Manufacturers of Complete Finishing Systems—including Metal Cleaning, Pickling, and Rust Proofing Equipment, Hydro-Filter Spray Booths, Dip and Flow Coaters, Filtered Air Supply Systems, Drying and Baking Ovens, Cooling Tunnels, Heat Treating and Quenching Equipment for Aluminum and Magnesium, and other Units of Special Production Equipment.

MAHON

Waldes Truarc Retaining Ring eliminates 7 parts, saves $8.88 in sub-assembly of aerial reconnaissance camera

Gordon Enterprises, No. Hollywood, California, saved the Navy almost 1½ million dollars on 500 cameras. Gordon rebuilt new, efficient "CA" series out of Navy-owned obsolete models. Critical parts are now held together by Waldes Truarc Retaining Rings.

Truarc Rings are trouble-free, will not change position during operation. Accuracy is limited only by groove and ring dimension tolerances. And standardized Truarc Rings are quickly interchangeable in overhaul which now takes only 11 minutes, can be handled by unskilled technicians.



Weight Saving: 7.25 oz.

Assembly Time Saving: . . . . . 6½ min.

DOLLAR SAVINGS:

Material	**$ .93**
Fabrication	**6.88**
Inspection	**1.07**
Total	**$8.88**

Truarc 5100-287 ring retains shutter speed adjustment mechanism on the Lens Adapter Plate Assembly which mounts and locks the lens and shutter assemblies accurately to camera body. Alternate design required retaining washer, spring, collar and 4 locking screws.

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

In Truarc, you get

Complete Selection: 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available quickly from leading OEM distributors in 90 stocking points throughout the U. S. and Canada.

Controlled Quality from engineering and raw materials through to the finished product. Every step in manufacture watched and checked in Waldes' own modern plant.

Field Engineering Service: More than 30 engineering-minded factory representatives and 700 field men are at your call.

Design and Engineering Service not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

For precision internal grooving and undercutting . . . Waldes Truarc Grooving Tool!

WALDES

TRUARC®

RETAINING RINGS

WALDES KOHINOOR, INC.
47-16 AUSTEL PLACE, L. I. C. 1, N. Y.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send new, descriptive catalog showing all types of Truarc rings and representative case history applications. *(Please print)*

Name ______
Title ______
Company ______
Business Address ______
City ______ *Zone* ______ *State* ______ ±AY010

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

FIRST TIME EVER!

Another

CYCOLAC®

HIGH IMPACT THERMOPLASTIC RESIN

ACHIEVEMENT

TRANSISTOR RADIO CASE CONTINUOUSLY EXTRUDED

PROVIDES FASTER PRODUCTION, EASIER ASSEMBLY, *LOWER MANUFACTURING COSTS...*

Only CYCOLAC measured up to all requirements for the first extruded transistor cabinets ever made! Imagination and engineering provided savings of 87% on dies and engineering costs alone. CYCOLAC also has many other outstanding properties which made this possible. High impact strength, bright glossy colors, light weight, dimensional stability, excellent shock resistance, chemical resistance, and superb electrical properties. Moving smoothly off the production line, extruded profiles are cut to width, speaker openings die-stamped, units inverted, cemented and presto! . . . cases are complete! To add to your profit picture, find out how CYCOLAC can help *you* make more attractive, better products and *save* money!

* **Extruded transistor radio cabinets used in Knight-Kits produced by Custom Plastics, Inc., for Knight Electronics Division of Allied Radio Corp., Chicago, Ill.**

Write Today for Technical Literature

PACESETTER IN

Marbon CHEMICAL

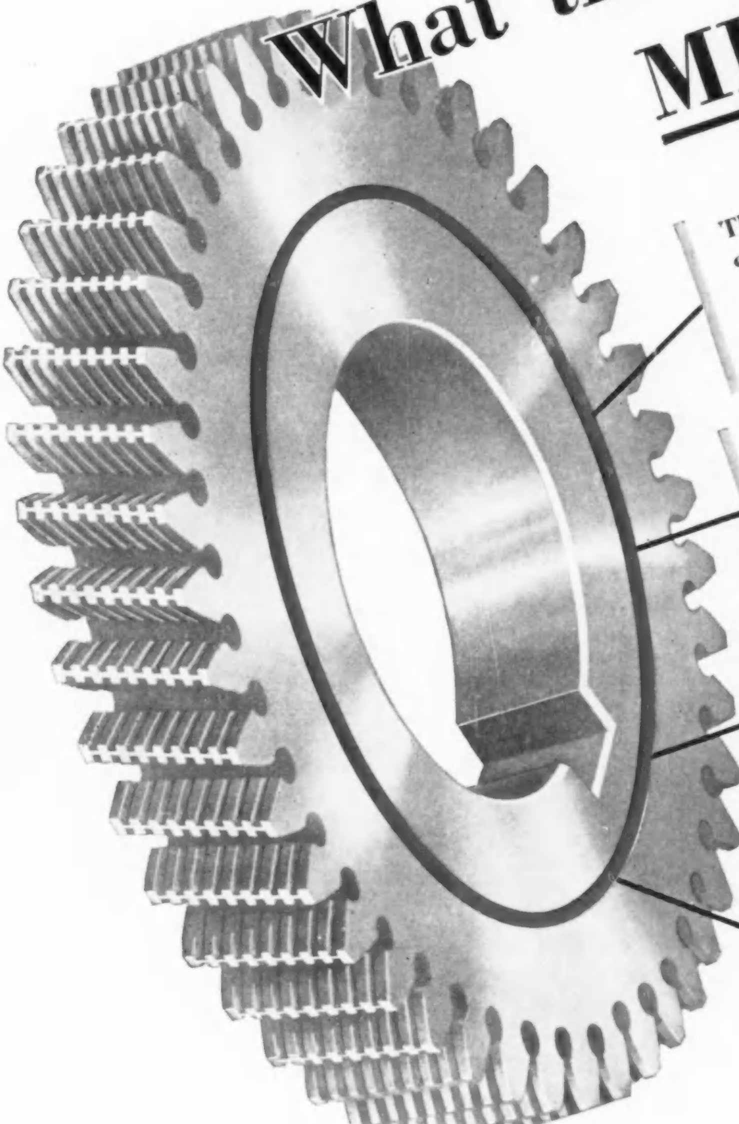
SYNTHETIC RESINS

Division of BORG WARNER • Gary, Indiana

also represented by:

WEST COAST: Harwick Standard Chemical Co., Los Angeles, Cal.
CANADA: Dillons Chemical Co. Ltd., Montreal & Toronto
EXPORT: British Anchor Chemical Corp., New York

What that Red Ring MEANS



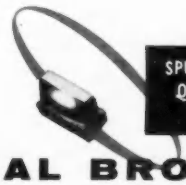
That Red Ring on a gear shaving cutter means it was made by an organization which has more experience and success in this field than any other in the world.

That Red Ring marks the product of engineers and shop men who devote all their working time to these CUTTERS — nothing else.

That Red Ring reminds the user that these specialists are ready to help him get off the hook if he runs into a troublesome gear problem.

That Red Ring says "This cutter is designed and manufactured to deliver the best possible shaving performance."

Write for bulletin CR 56-10



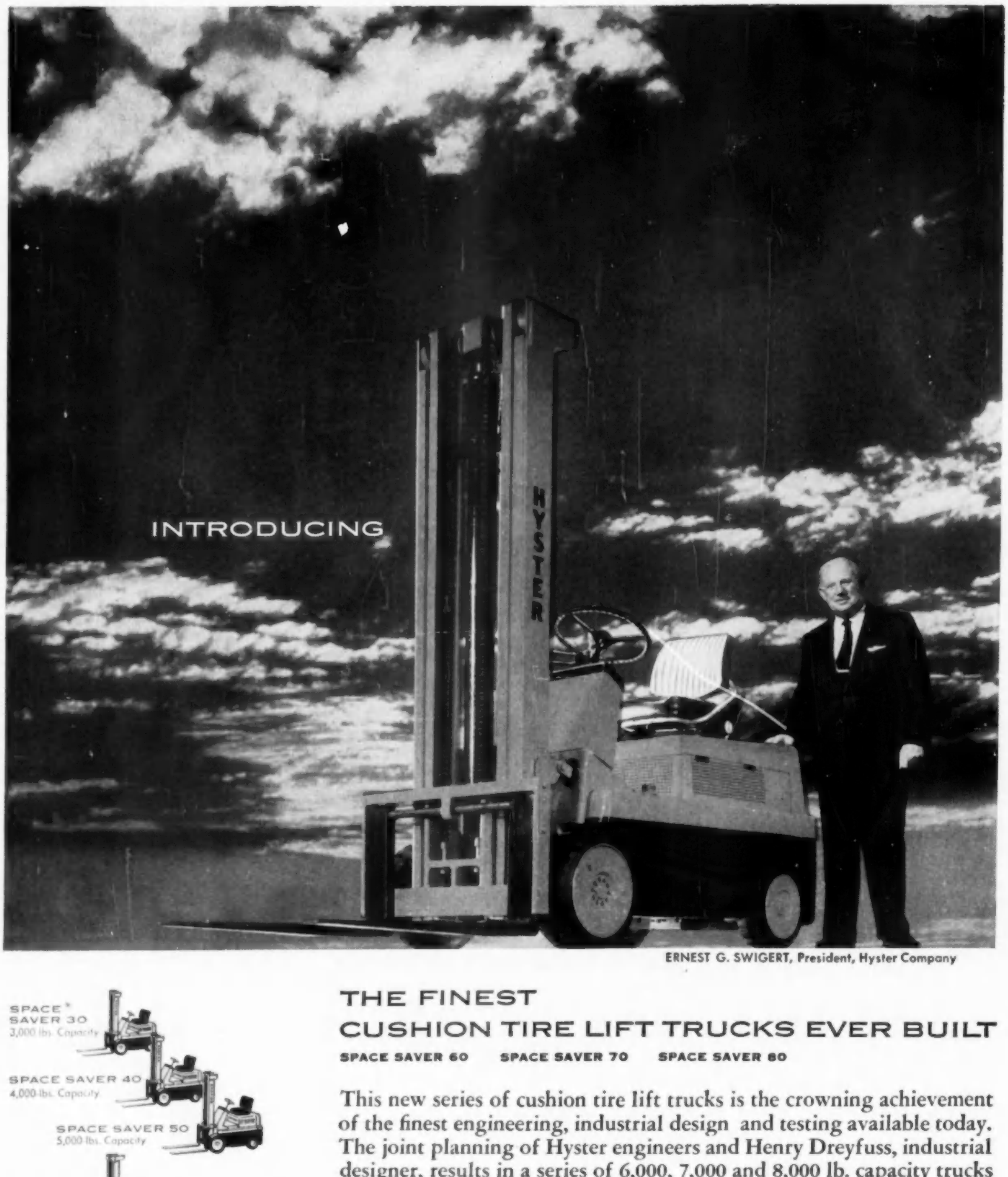
SPUR AND HELICAL GEAR SPECIALISTS
ORIGINATORS OF ROTARY SHAVING
AND ELLIPTOID TOOTH FORM

NATIONAL BROACH & MACHINE CO.

5600 ST. JEAN • DETROIT 13, MICHIGAN

WORLD'S LARGEST PRODUCER OF GEAR SHAVING EQUIPMENT

7968



ERNEST G. SWIGERT, President, Hyster Company

THE FINEST CUSHION TIRE LIFT TRUCKS EVER BUILT

SPACE SAVER 60 SPACE SAVER 70 SPACE SAVER 80

This new series of cushion tire lift trucks is the crowning achievement of the finest engineering, industrial design and testing available today. The joint planning of Hyster engineers and Henry Dreyfuss, industrial designer, results in a series of 6,000, 7,000 and 8,000 lb. capacity trucks unequalled for productive maneuverability, operating economy and handling efficiency.

Prove to yourself why we say these trucks are, without question, the finest cushion-tire lift trucks ever built. Schedule a demonstration at your own plant, or see them today at any Hyster dealer store.

Functionally styled by Henry Dreyfuss.

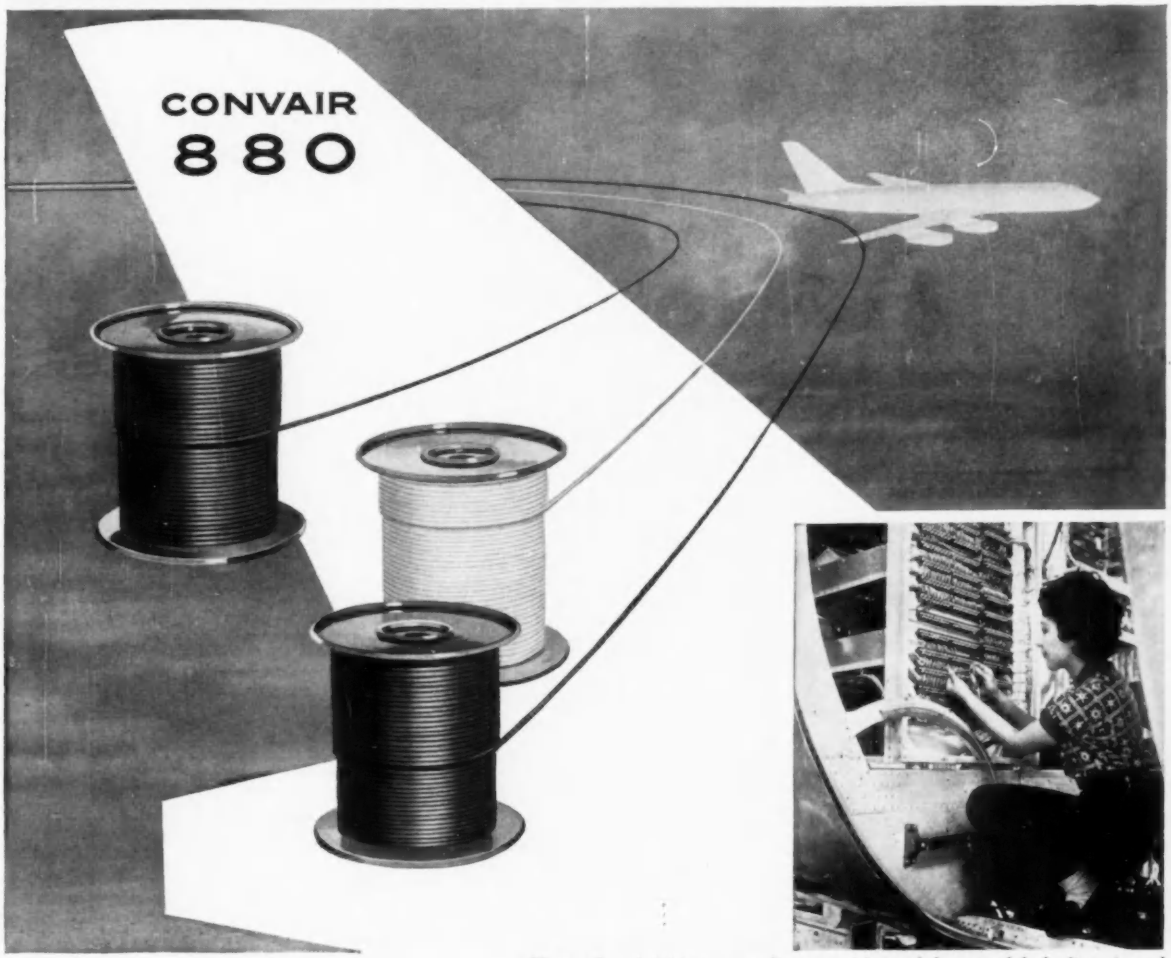
HYSTER®

World's foremost manufacturer of Industrial Trucks

Factories: Portland, Oregon • Danville, Illinois
Peoria, Illinois • Nijmegen, The Netherlands
Sao Paulo, Brazil • Glasgow, Scotland
Sydney, Australia (licensee)

Another new development using

B.F.Goodrich Chemical *raw materials*



The new Convair 880 jet passenger liner uses wiring made by many of the leading wire and cable companies. B.F.Goodrich Chemical Company supplies the Geon polyvinyl material only.

15 MILES OF GEON HELP JET-LINER BEAT THE HEAT

MOVING East to West just a step behind the sun, this new jet passenger liner will make it from New York to Los Angeles in 4 hours 32 minutes. Hard at work inside this plane of tomorrow will be wire whose 15 miles of tough insulation is made of a unique new Geon polyvinyl compound.

Why Geon Was Chosen—Geon 8800 compound has 5 *times* the insulation resistance of previously available insulations over the full operating temperature range. The exceptional heat stability of Geon 8800 provides the superior performance required for jet aircraft wiring. These properties offer advantages as well for appliances, computers, machine wiring and similar applications.

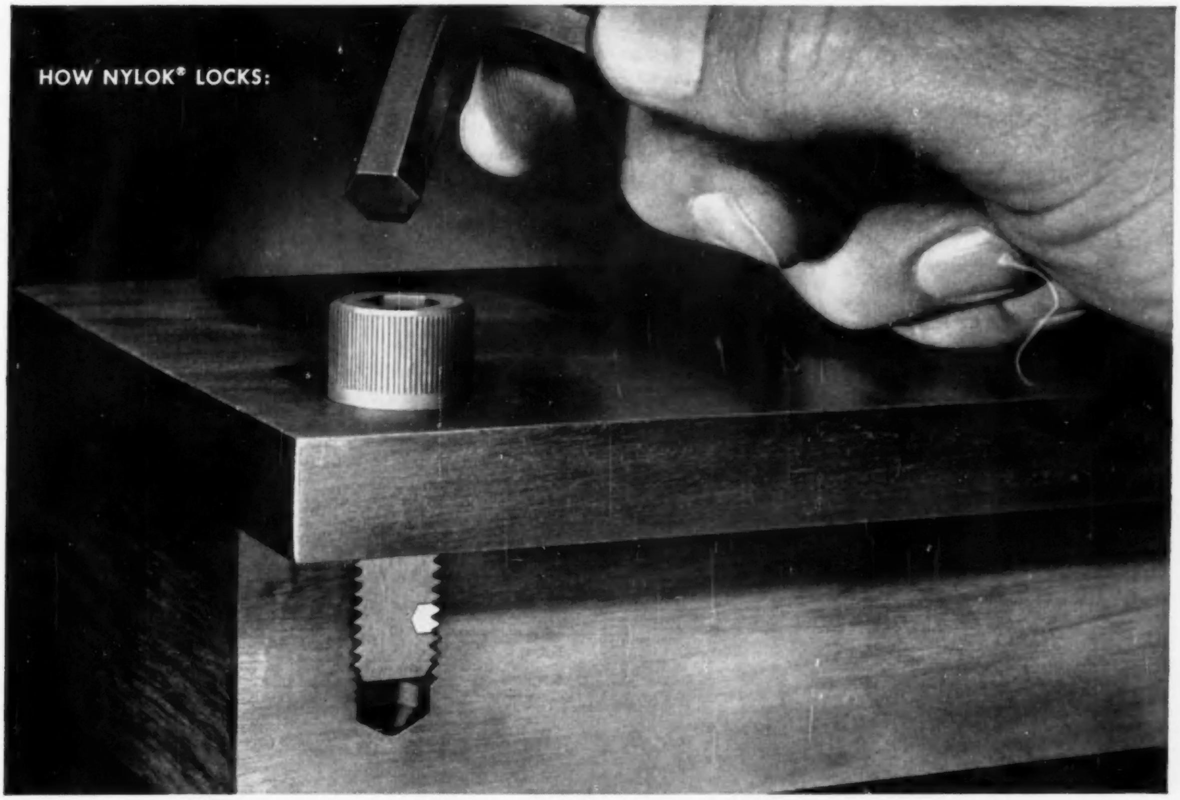
How We Can Help You—Versatile Geon polyvinyl materials, in addition to providing flexible electrical insulation, are used for rigid piping and valves, protective coatings for steel, paper, upholstery. B.F.Goodrich Chemical supplies hundreds of types of resins, plastics, latices, and polyblends tailored to specific uses.

For information on applications write Dept. LN-1, B. F. Goodrich Chemical Company, 3135 Euclid Ave., Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

Geon Polyvinyl Materials

B.F.Goodrich Chemical Company
a division of The B.F.Goodrich Company

B.F.Goodrich GEON polyvinyl materials • HYCAR American rubber and latex • GOOD-RITE chemicals and plasticizers • HARMON colors



LOCKED! The tough, resilient nylon pellet keys itself into the mating threads. It forces threads together, and locks the screw securely.

NEW—a complete line of <u>self-locking</u> UNBRAKO socket screw products that won't work loose

They simplify design and save production time

UNBRAKO socket screws are now available embodying the Nylok self-locking principle. Nylok provides a truly practical new solution to the problem of making screws self-locking.

You save production time when you build products with self-locking UNBRAKOS. And you get greater simplicity in design with less bulk and weight. The number of parts you must assemble to achieve full locking action is reduced to the absolute minimum. Lockwashers under screw heads are no longer necessary. Costly wiring of cross drilled heads is eliminated. So are cotter pins and complex multiple set screw installations.

Self-Locking UNBRAKOS are completely reusable. They have uniform locking and installation torques—with no galling or seizing on mating threads. They successfully withstand temperatures from —70° to 250°F. And, on properly seated screws, the pellet acts as a liquid seal.

Self-locking UNBRAKO socket screws come in a complete range of standard sizes and materials. See your authorized industrial distributor. Technical data and specifications are detailed in Bulletin 2193. Write us for your copy today. Unbrako Socket Screw Division, STANDARD PRESSED STEEL CO., Jenkintown 53, Pa.

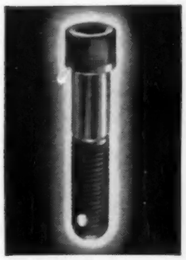
We also manufacture precision titanium fasteners. Write for free booklet.

UNBRAKO SOCKET SCREW DIVISION

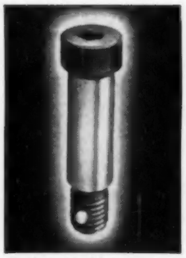
STANDARD PRESSED STEEL CO.

SPS

JENKINTOWN PENNSYLVANIA

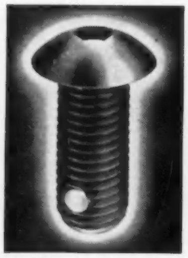


Socket head cap screws. Standard sizes #6 to 1 in.

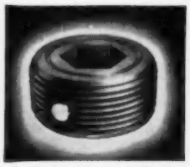


Socket shoulder screws. Standard sizes 1/4 to 3/4 in.

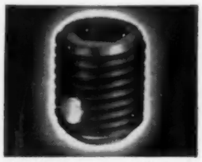
Flat head socket screws. Standard sizes #6 to 3/4 in.



Button head socket screws. #6 to 5/8 in.



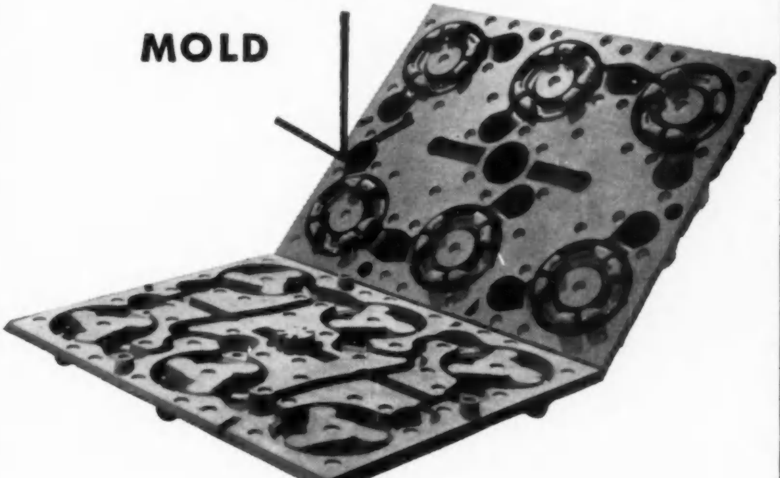
Socket pressure plugs. Standard sizes 1/16 to 1 1/4 in.



Socket set screws. All standard point types. #6 to 1 in.

THIS CLEAN, SHARP

MOLD



PRODUCES THESE CLEAN,

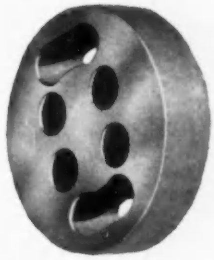
SMOOTH, SHARP CASTINGS

CENTRAL FOUNDRY DIVISION

GENERAL MOTORS CORPORATION
SAGINAW, MICHIGAN • DEPT. 24

83

Hydraulic Pump Ring



Power Steering Pressure Plate

Transmission Governor Body

Universal Joint Yoke

Automatic Transmission Drum

CALENDAR

OF COMING SHOWS AND MEETINGS

1958

Chicago Automobile Show, International Amphitheatre, Chicago, Ill. ....Jan. 4-12

SAE Annual Meeting and Engineering Display, Sheraton-Cadillac and Statler Hotels, Detroit, Mich. ....Jan. 13-17

National Motor Boat Show, Coliseum, New York, N. Y.....Jan. 17-26

Truck-Trailer Manufacturers Association, annual convention, Palm Beach Biltmore, Palm Beach, Fla. ....Jan. 20-22

Plant Maintenance and Engineering Show, International Amphitheatre, Chicago, Ill. ....Jan. 27-30

Instrument Society of America, national conference on chemical and petroleum instrumentation, Wilmington, Del. ....Feb. 3-4

Automotive Accessories Manufacturers of America Exposition, Navy Pier, Chicago, Ill......Feb. 3-6

Reinforced Plastics Division of Society of Plastics Industry, Inc., annual technical and management conference, Edgewater Beach Hotel, Chicago, Ill....Feb. 4-6

American Society for Quality Control, Administrative Applications Div. annual conference, Carter Hotel, Cleveland, O...Feb. 7-8

Motor and Equipment Wholesalers Association, national convention, Statler Hotel, Los Angeles, Calif. ....Feb. 18-19

Pacific Automotive Show, Pan Pacific Auditorium, Los Angeles, Calif. ....Feb. 20-23

Leipzig Spring Fair, Leipzig, Germany ....Mar. 2-11

ASME Gas Turbine Power Div. Conference and Exhibit, Shoreham Hotel, Washington, D. C. Mar. 3-6

SAE Passenger Car, Body and Materials Meeting, Sheraton-Cadillac Hotel, Detroit, Mich.....Mar. 4-6

Instrument Society of America, Pittsburgh Section Annual Conference on Instrumentation for Iron and Steel Industry, Roosevelt Hotel, Pittsburgh, Pa..Mar. 11-13

Steel Founders' Society of America, annual meeting, Drake Hotel, Chicago, Ill. ....Mar. 17-18

International Atomic Exposition, Inc., International Amphitheatre, Chicago, Ill. ....Mar. 17-21

SAE Production Meeting and Forum, Drake Hotel, Chicago, Ill. ....Mar. 31-Apr. 2

International Automobile Show, N. Y. Coliseum, New York, N. Y. ....Apr. 5-13

American Welding Society Show and annual technical meeting, Kiel Auditorium and Hotel Statler, St. Louis, Mo. ....Apr. 14-18

American Society for Metals, Southwest Metal Exposition and Congress, Dallas, Tex. ....May 12-16

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High Spots of This Issue

▼ Soviet Industrial Growth

This article, based on studies by the Foreign Manpower Research Office, attempts to assess the economic and social costs of Russian industrialization, as well as Soviet industry's major achievements, failures, structural peculiarities, and prospects for further growth. Page 48.

▼ Soviet Automotive Industry

In attempting to account for the backward state of the Russian automotive industry, the author discusses such shortcomings as obsolescent technology, inefficient organization of labor, the strong hand of bureaucracy, as well as shortages of material, funds, and qualified personnel. Page 60.

▼ First-Hand Report on Russia's Motor Vehicle Industry

David Scott, AUTOMOTIVE INDUSTRIES' British correspondent, made a trip to Moscow in September, 1957, to gather material for this three-part article. He inspected two of Russia's largest automotive factories and also examined the latest Soviet vehicles on display at the permanent industrial exposition in Moscow. Page 78.

▼ Soviet Transportation

This two-part analysis of the strengths and weaknesses of the Soviet transportation system includes valuable data on railroads, the primitive highway system, private passenger cars, trucks, buses, and aircraft. A penetrating discussion of possible future transportation developments is also included. Page 96.

▼ Evaluation of Soviet Missile Program

Russia's large family of missiles is covered in this comprehensive report. Evaluated here are such impressive achievements as the T-1 and T-2 intermediate range ballistic missiles, the T-3 ICBM, the Soviet satellite program, as well as reports of an 800,000-lb rocket engine now under development for the T-4A hypersonic glide bomber. Page 103.

▼ New Product Items And Other High Spots, Such As

Missile procurement agencies; machinery news; metals report; Washington wire; and industry statistics.

News

OF THE AUTOMOTIVE AND AVIATION INDUSTRIES

Vol. 118, No. 1 **January 1, 1958**

High Rambler Sales Give AMC Fast Start on Fiscal Year

Higher sales of the Rambler car have given American Motors a fast start on its current fiscal year, and for the first quarter (through Dec. 31), profits topped $3 million.

In the first two months of the current year (October and November), Rambler sales totaled 20,346 units. A year ago the number was 11,826. November showed a 10 per cent increase over October.

An encouraging factor was AMC's rate of production at its Kenosha, Wis., plant. Although Rambler production climbed during December, production still was five to seven weeks behind sales by month's end.

The first week of December, production totaled 2923 units, the following week it was 3338, and in the week ended Dec. 20, 3600 units were scheduled.

The six-week backlog of orders means that the factory could work at a steady clip even in the face of an industry-wide slump.

George Romney earlier predicted his company would sell 186,000 Ramblers during 1958.

AMC is in a strong dealer position as it starts the new calendar year, with some 350 more dealers under franchise than one year ago.

The interim report which cited the $3 million quarterly profit also listed the final losses for the fiscal year ended Sept. 30 as $11,833,200.

RAMBLER AMERICAN IS LESS THAN 15 FT LONG

Rambler American, a five-passenger, two-door sedan, is American Motors Corp.'s latest entry in the small car field. New model is built on a 100-in. wheelbase and is powered by a six-cylinder 195.6 cu in. engine developing 90 hp. Compression ratio is 8 to 1; bore and stroke measurements are 3 1/8 by 4 1/4 in. Car is less than 15 ft long, and is only 57 1/3 in. high and 73 in. wide. A two-door Club Sedan will be available in the DeLuxe and Super Series, and fleet buyers will be offered a DeLuxe business coupe.

Station Wagon Production Up 3.4 Per Cent in 1957

Station wagon production increased some 3.4 per cent during the first nine months of 1957, accounting for some 14.4 per cent of total passenger car production.

A total of 677,230 station wagons were built in U. S. plants, including 523,732 four-door models. A year ago, the total was 470,910 station wagons for 11.03 per cent of all passenger cars built.

Ten years ago only 2.24 per cent of the cars produced were station wagons. Growth of suburbs and popularity of the station wagon as a second car have contributed to the increasing demand.

Governors' Committee To Meet With AMA To Discuss Safety

The highway safety committee of the Governors' Conference will meet soon in Detroit with the Automobile Manufacturers Association to discuss "the entire safety problem as it relates to the manufacturers." The meeting replaces one tentatively planned earlier to include all 48 governors.

Willys Predicts Export Sales Of About $70 Million in 1958

Willys-Overland Export Corp. expects overseas sales of Jeep vehicles and parts to total some $70 million during 1958. This would top estimated 1957 export sales by some $5 million.

An official of the export organization said recently that Jeep sales would amount to 61,385 units during the coming year. This, plus parts business, would make 1958 the company's best year.

Jeeps are assembled or manufactured at 19 plants in 19 foreign countries. Willys-Overland Export sells the entire line of Jeep four-wheel drive in the export market.

Meanwhile, Willys Motors, Inc. estimated that factory sales of Jeeps during the final quarter of 1957 were some 20 per cent above the highest previous quarter of the year.

News AUTOMOTIVE AND AVIATION

New, longer Thunderbird is only 52.5 in. high

1958 Thunderbird to Have All Ford Accessory Options

The 1958 four-passenger Thunderbird will be available with all Ford special accessory options, including air conditioning and air suspension. The two door hardtop model (see illustration) will be the only body style offered at the present time.

The new Thunderbird is built on a 113-in. wheelbase, has an overall length of 205.4 in., overall height of 52.5 in., and weighs around 3850 lb.

The standard engine will be the new 352 cu in. Ford OHV, V-8, rated at 300 hp, with a four-barrel carburetor.

Three different transmissions are available as options: the standard Ford Interceptor three-speed syncromesh transmission; overdrive; and Cruise-O-Matic. Rear axle ratios include 3.70 to 1 with the manual shift transmissions, and 3.10 to 1 with Cruise-O-Matic.

Chrysler Corp. Can Count 1957 As 2nd Best Production Year

Chrysler Corp. can count 1957 as its second best production year in history, ranking only behind the boom year of 1955.

In the calendar year just ended, Chrysler built some 1,312,000 cars and trucks. This is well over the previous year's total of 961,644 units, and a scant 144,000 under the 1955 total.

Chrysler ended the year with earnings estimated at $130 million, or better than $15 a share. A year ago the corporation could count only $19,952,969 in profits, a relatively slim $2.29 a share.

The company's big boost in passenger car sales lifted Chrysler market penetration from less than 15 per cent a year ago to more than 20 per cent during 1958.

AUSTIN CAMBRIAN FEATURES STYLING AND ECONOMY

The 1958 Austin A-55 Cambrian, a trim British-built, four-door sedan, is powered by a four-cylinder 90.82 cu in. engine with a compression ratio of 8.3 to 1. The car has a 99.25 in. wheel base, overall length of 167 in., and height of 60 in. Manual transmission has four forward speeds with overdrive as optional equipment. Car is available through more than 500 distributors and dealers in U. S. and sells for around $2200.

New, Lightweight GMC Tractor Makes Liberal Use of Aluminum

GMC Truck & Coach Div. says its new model DR862 highway tractor, equipped with air suspension, is more than half a ton lighter than comparable tractors of the same GCW ratings.

Reason for this is the "liberal" substitution of aluminum for steel in many places, because less structural rigidity is needed. Air springs eliminate many road shocks and vibrations before they reach the cab and chassis.

The new model is powered by a GM 6-71 Diesel with a 190 hp rating at 2000 rpm. Standard equipment includes a 5-speed, overdrive syncromesh transmission, 9000 lb tubular front axle and 22,000 lb two-speed rear axle. An optional combination is a 10-speed transmission with single-speed rear axle rated at 22,000 lb.

Wheelbases of 140 and 164 in. provide CA dimensions of 78 and 102 in.

The new DR862 is the 13th GMC highway tractor equipped with air suspension.

Buick Drops Kudner Agency; No Replacement Is Named

Buick Div. has dropped Kudner Agency, Inc., after 22 years of affiliation with the New York-Detroit advertising firm. Buick's advertising billings total approximately $25 million annually.

Kudner retains several other General Motors advertising accounts, including GM institutional, Fisher Body, GMC Truck & Coach and Allison divisions. No replacement has been named for Kudner.

Two factors in Buick's decision reportedly were the loss of third place to Plymouth and the handling of commercials on a televised fight last summer.

J. & L. Producing Steel By Basic Oxygen Process

Jones & Laughlin Steel Corp., the nation's fourth largest steel producer, has begun making steel by the basic oxygen process at its Aliquippa, Pa., works.

The company's two basic oxygen furnaces—only one of which will operate at a time — have a total annual rated capacity of 750,000 tons, and are believed to be the largest in the world. Company officials estimate the cost of the complete installation to be about $11 million.

Avery C. Adams, president and chief executive officer of J. & L., said that the basic oxygen process not only produces high-quality steel but that facilities cost much less than conventional ones. The basic oxygen furnaces at J. & L. represent a capital investment of only $15 a year per ingot ton, compared with at least $40 for new open hearth facilities.

The process is relatively simple. It is carried out in a cylindrical furnace lined with basic refractories. The furnace is charged with scrap, molten iron, and slag-forming materials.

A water-cooled lance is lowered to a predetermined position above the surface of the molten metal. From the tip of the lance, a jet of high-purity oxygen is directed at the surface of the molten bath, initiating the thermo-chemical reactions that refine the iron to steel.

JAPANESE FIRM TO SELL CAR IN U.S. MARKET

Tyopet Crown DeLuxe passenger car, built by Toyota Motor Co. of Koromo, Japan, was exhibited at the Tokyo Auto Show recently. The car, which seats six passengers, is mounted on a 100-in. wheelbase and has an engine rated at 55 hp. Company expects to introduce the car to the U.S. market sometime this year at a price of about $2000.

Chrysler Completing New Lab For Vibration and Noise Test

Chrysler is completing a nine-room laboratory designed to isolate and analyze sounds and vibrations of cars and trucks in action. Last of the rooms, including a suspended "quiet" room, are to be finished early this year.

In the sound-proof vibration room, engineers are able to pinpoint vibrations in the engine and drive train by simulating road tests up to 125 mph. The equipment is designed to duplicate, electronically, nearly any outside driving condition. But the tests are conducted without misleading wheel vibrations and wind, road and tire noises that accompany outdoor road tests.

Twin 250 hp dynamometers are connected by propeller shafts to the two rear wheels. The axle shaft rotates on special roller bearings mounted between the brake drum hubs and the wheel disks.

In other test rooms, engineers can analyze vibrations and their effect on frame and chassis components. Two electromagnetic vibrators give the cars a shaking which equals that of the worst country road. Each vibrator is capable of exerting 200 lb of force and giving up to 500 shakes per second.

The suspended room, yet to be finished, will be mounted and cushioned by heavy-gage coil springs. The room will be completely immune to noises and vibrations of surrounding buildings, cranes, railroads, and other influences.

Chevrolet Sets Weekly Record With Passenger Car Output

Chevrolet Div. set a weekly production record with 44,920 passenger cars for the week ended Dec. 14. The previous record was set only three weeks earlier, when 44,795 cars were built.

Chevrolet set its record as it picked up production on its 1958 model. To build the cars, the division worked six days at all plants and two shifts daily at all but two plants.

Buick Installs New Device To Measure Air Spring Rate

Buick has installed a new device on its final assembly line to measure the recovery rate of air springs. The instrument duplicates car weight bouncing on the air spring, and checks rate at every position of compression and rebound.

Results are recorded on a force vs position curve defined on a 17-in. oscilloscope.

SMALL MASERATI HAS HIGH-COMPRESSION ENGINE

Maserati Type-S 187 sports car is powered by a four-cylinder, 44.52 cu in. engine that develops 70 bhp at 7500 rpm. Bore and stroke are each 2.42 in.; compression ratio is 9 to 1. The two-passenger car is built on an 82.68 in. wheelbase and weighs 948 lb.

News AUTOMOTIVE AND AVIATION

TRACTOR IS POWERED BY NEW DIESEL ENGINE

The Model 923 tractor built by Diamond T Motor Car Co. is powered by the completely new Cummins HF-6-B, 672 cu in. Diesel engine rated at 180 bhp at 2100 rpm. Maximum torque output is 450 lb/ft. Tractor has a GCW rating of 60,000 lb with standard rear axle and GVW rating of 29,000 lb for the standard model.

Motor Wheel Corp. Inaugurates $3 Million Plant in Delaware

Motor Wheel Corp. has opened a $3 million, 85,000 sq ft plant at Newark, Del. for the manufacture of automobile wheels, hubs, drums and tubular steel parts.

The plant has a capacity for 25,000 ft of tubing, 5000 wheels and 2500 hubs and drums on an eight-hour shift. Stamping and forming of wheel rims and disks is done by a battery of presses ranging in capacity from 100 to 1000 lb.

The new Motor Wheel plant uses spiral-shaped vertical storage bins to maintain a uniform supply of basic components for wheel production lines (see illustration). The units are filled from the top with components which are gravity fed to the line.

The plant was built to serve the eastern automobile assembly plants. Ten of the 16 plants in the east are within 200 miles of Newark.

IRS Allows Refunds On Tax Overpayment

Automobile manufacturers may be missing an opportunity to get refunds, with interest, on overpayment of Federal excises on auto accessories.

Internal Revenue Service makes this point in a new finding, Revenue Ruling 57-582. The ruling deals specifically with the tax paid on tires for a trailer. But it applies equally to taxes on inner tubes and radio or television receivers sold in connection with automobiles and other motor vehicles.

A trailer manufacturer requested IRS to rule on his chances for a refund on his tax payment for tires. The tires, already taxed, were part of the equipment of a trailer sold by the manufacturer. He paid the tax on the complete sales price, taking no credit for the tax paid on the tires.

In answer to his request, IRS says the manufacturer is due a credit or refund of the tax overpayment. Interest is allowable in connection with the refund.

New Dutch Car by DAF To Be Unveiled in Feb.

A small four-passenger car built in Holland will be displayed at the Amsterdam Automobile Show in February.

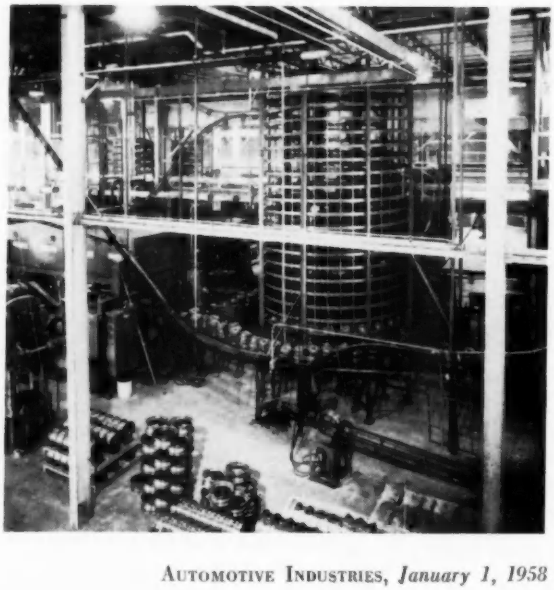
The new car, powered by a 40 cu in. engine, will be assembled by Van Doorne's Automobilfabriek (DAF) from components made mostly in Holland. Production is scheduled to begin late this year, with an annual production target of 25,000 cars to be reached in one or two years.

Ford Consolidates Waterford Operations at Rawsonville

Ford Motor Company has moved operations of its Waterford instrument plant to the new Rawsonville plant near Ypsilanti, Mich. The 32-year old Waterford plant will be sold. Two other small Ford hydro-factories already have been consolidated with the 750,000 sq ft Rawsonville plant, which was completed last spring.

STORAGE UNIT

Large spiral-shaped bin is used to feed wheel rims into production line as needed. Installed by Motor Wheel Corp. in its new plant at Newark, Del., vertical storage unit has capacity of 1000 wheel rims, and is loaded from the top. An elaborate network of overhead conveyors boosts production and minimizes floor level handling. Plant will manufacture passenger car and truck wheel assemblies and automotive tubular parts.



HUGE CENTRIFUGE

This huge centrifuge will be used at Convair (Astronautics) Div. of General Dynamics Corp. plant to test components of Atlas ICBM. Machine whirls a one-ton load at 121 rpm and can simulate extremes of both temperature and G forces in environmental testing. It was built to Convair specifications by Rucker Co. of Oakland, Calif.

Rubber Executive Forecasts Tire Sales of 114 Million

Rubber executive William O'Neill predicts that his industry will sell 114 million tires during 1958, or roughly 4 million more tires than in 1957 and slightly under the record of 114,306,000 in 1955.

The head of General Tire & Rubber Co. says passenger car replacement tire sales will show the biggest gain —up as much as 5 per cent. Replacement sales in 1957 were approximately 56.5 million tires.

Four Wheel Drive Earnings Drop as Sales Rise in '57

Earnings of Four Wheel-Drive Auto Co. fell 15 per cent during fiscal 1957 (through Sept. 30), although sales showed a 16 per cent increase. The company cited increased interest expenses, government sales at "low profit margins," and a nonrecurring administrative expense as reasons for the decline in earnings.

For the year, earnings totaled $487,016, compared with $577,176, a year ago. Sales amounted to $21,187,804 for the fiscal year.

DeSoto Had Third Best Year In 1957 with 117,326 Cars

DeSoto Division counted 1957 model year as its third best in history. DeSoto shipped 117,326 cars during the year. The division says that its share of the market has increased by 27.3 per cent since 1954.

AI TABLOID

Lockheed's Georgia Div. has installed an ultrasonic test tank, operated on the impulse-echo principle, that can identify and locate flaws in forgings and extrusions. The ultrasonic pulses are reflected from the surfaces or internal defects of the materials and are visually indicated as pips on a cathode ray tube.

* * *

Chance Vought Aircraft, Inc. has been awarded an Air Force contract to develop foundry methods for casting high-strength steel alloys for supersonic aircraft. Data obtained will be made available by Air Force to all foundries producing castings for military aircraft.

* * *

Aerojet-General Corp. has delivered the first production-type engine on the Titan ICBM to Martin Co. of Denver, prime contractor for the missile.

* * *

Convair Div. of General Dynamics Corp. reports that the supersonic B-58 Hustler is now being readied for Phase IV testing. This part of the test program usually starts when an aircraft is committed for quantity production.

* * *

Ramsey Corp., a Thompson Products, Inc. subsidiary, has begun production at its new piston ring plant in Manchester, St. Louis.

* * *

American Society for Metals has formed a "Free World Metal Science Brainpower Pool" to speed exchange of important metals information. Leaders of some 20 metal societies represented at the recent world metals Congress will make up the membership of the pool.

* * *

As part of its contribution to the current Carnegie Institute of Technology $24 million development campaign, Firth Stirling, Inc. has established a chair of metallurgical engineering at the Institute.

* * *

National Bureau of Standards reports that bubbles large enough to be seen by the unaided eye form in some stressed metals that develop fatigue cracks. Further tests along these lines, NBS says, may make it possible to detect the onset of fatigue cracking in some metals.

A new type of bearing alloy composed of tin (about 20 per cent) and aluminum hardened with from 1 to 3 per cent copper has been developed by the Tin Research Institute and Glacier Metal Co. of England. When supplied in the form of steel-backed bearings, the Institute claims, the alloy provides excellent balance between the opposing demands of high-fatigue strength and low rates of wear.

* * *

Young Spring & Wire Corp. has purchased the assets of Canadian Automotive Trim, Ltd., a major supplier of automotive trim products to the Canadian automobile industry.

* * *

American Bosch Arma Corp. has opened a new 20,000 sq ft plant in the Chicago area for the design, development and production of complex test and ground support equipment.

* * *

Detroit Harvester Co. will build a new research center in Detroit with elaborate facilities for testing and experimentation, and a model laboratory for constructing prototypes of new products.

* * *

Champion Spark Plug Co. is now making auxiliary-gap type spark plugs. The added gap at the top of the center electrode causes an increase in voltage at the firing end of the plug, which can greatly reduce oil and carbon fouling, particularly at idling and low speeds.

* * *

Westinghouse Electric Corp. has developed test equipment weighing less than 15 lb that can make a complete check of an airplane's electronic gun aiming system in flight as well as on the ground in a matter of minutes.

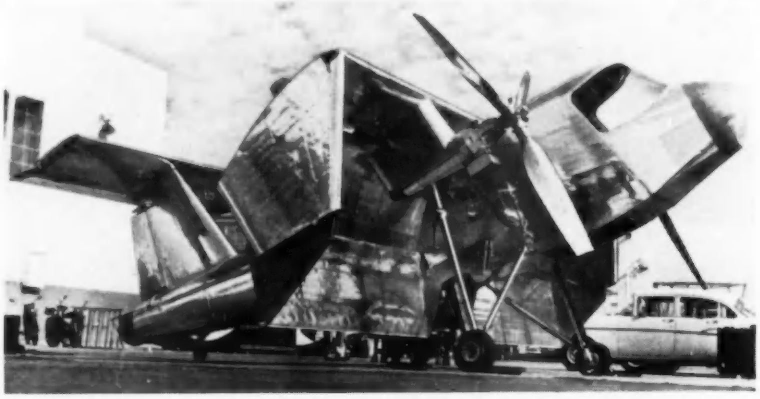
* * *

Twenty-five years ago, Henry Ford announced that he would mass produce a V-8 engine by casting the engine block in one piece. Last month, Ford Motor Co. turned out its 25 millionth V-8 engine at its Lima, O., plant.

* * *

The Esso Education Foundation is contributing $500,000 to 84 colleges and universities to encourage science teaching at all school levels.

AVIATION MANUFACTURING



RYAN VTOL HAS DOUBLE RETRACTABLE WING FLAPS

This strange-looking aircraft, called the Vertiplane, takes off and lands without any ground run. Built by Ryan Aeronautical Co. for the Army under Office of Naval Research direction, the VTOL Vertiplane gets its lift from double retractable wing flaps which deflect the propeller slipstream downward. The two-seater Vertiplane is powered by a Lycoming T-53 gas turbine engine in the fuselage and is 27 ft, 8 in. long; 10 ft, 8 in. high; has a wing span of 23 ft, 5 in.; and weighs about 2600 lb.

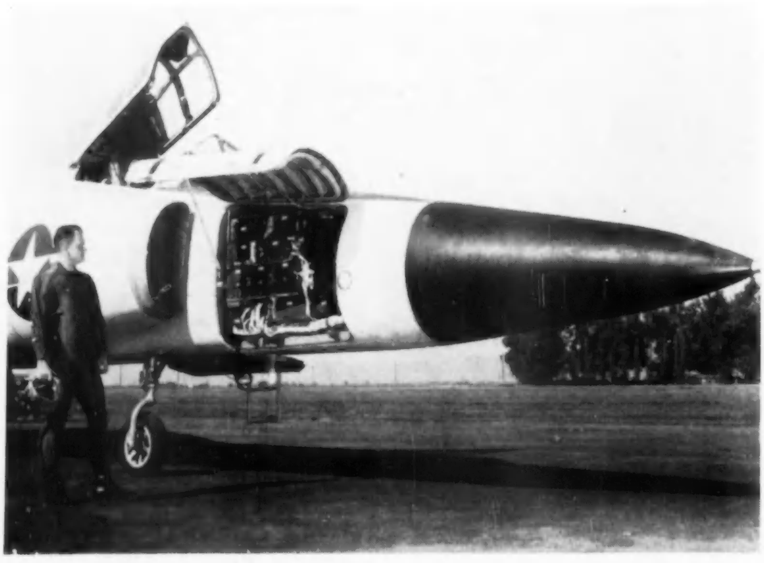
Airborne Digital Computer Can Fly Jet Interceptor

Hughes Aircraft is now producing an airborne digital computer that can fit into the cabinet of a table model TV.

Called Digitair, the computer can automatically fly a jet interceptor plane through all phases of supersonic combat, from takeoff to touchdown, leaving the pilot free for tactical decisions.

Digitair can make 9600 arithmetical computations a second, the company says. Working with coded information flashed to it by ground stations and the plane's own radar, Digitair simultaneously monitors 16 separate navigation and control functions during a program cycle of 1.8 seconds.

Company officials explained that the computer's light weight (120 lb) is made possible through the use of new miniaturization techniques—such as tiny diodes the size of match heads—and etched circuitry.



Prototype test model of Digitair computer installed in F-102A interceptor

Republic to Assemble, Market French Roto-Jet Helicopter

Alouette II, jet powered French helicopter, will be assembled and marketed in this country by Republic Aviation Corp., according to a joint announcement by Mundy I. Peale, Republic president, and Georges Hereil, president and director general of Sud Aviation of France.

Under the licensing agreement, all components and the engine will be produced in France for assembly in this country by Republic. American production of the helicopter will be phased in gradually, Republic officials said.

Republic also announced that it has formed the Helicopter Div., to handle sales, production, and flight testing of the Alouette. The division will occupy separate facilities at Republic's main aircraft plant, at Farmingdale, N. Y.

The Alouette, a five-place, medium-range (345 miles) roto-jet, is powered by a 360-hp Artouste IIB-1 gas turbine engine produced by Turbomeca of France.

Efficient Long-Range Rockets Predicted by NACA Scientist

Rocket-powered vehicles of the future may be just as efficient in long range flight as supersonic airplanes, says H. Julian Allen, chief of High Speed Research Div. of Ames Aeronautical Laboratory.

Allen said that rocket vehicles can carry a higher ratio of payload longer

distances than jet-powered planes. In addition, the rocket motor has the advantage of relatively light weight. Except for some surfaces that may encounter high heating rates, the structures of ballistic and glide rockets do not present insoluble problems.

Allen predicted that grave new problems will appear as the conquest of space progresses. He pointed out that experience with air-breathing engines has been largely restricted to the stratosphere. Greater emphasis is now being placed, he said, on understanding the whole atmosphere—not only chemical and physical characteristics, but also meteors, cosmic rays, and other high-energy particles.

Earlier this year, Allen received the highest award of the National Advisory Committee for Aeronautics for his basic research on blunt nose cones.

Wells Is Elected President Of Aeronautical Institute

The Institute of the Aeronautical Sciences has elected Edward C. Wells, Boeing Airplane Co. vice-president for engineering, as its president for 1958.

He succeeds Mundy I. Peale, president of Republic Aviation Corp.

Five institute vice-presidents also were named: Neil Burgess of General Electric Co.; Gen. B. W. Chidlaw, Thompson Products, Inc.; L. Eugene Root, Lockheed Missile Systems Div.; H. G. Stever, M.I.T. School of Engineering; and R. Dixon Speas, aviation consultant.

Officers will be installed Jan. 28, at the IAS Honors Night Dinner.

Small Lightweight Jet Engines May Be Answer to Rising Costs

Small, lightweight jet engines now under development may be the answer to rising costs in the aircraft industry, according to Louis W. Davis, assistant to the vice-president in charge of the Engine Div., Fairchild Engine & Airplane Corp.

In addition to cutting costs, he told the American Society of Mechanical Engineers, small turbojets in the 1000 to 3000 lb thrust range will enable designers to create new types of aircraft.

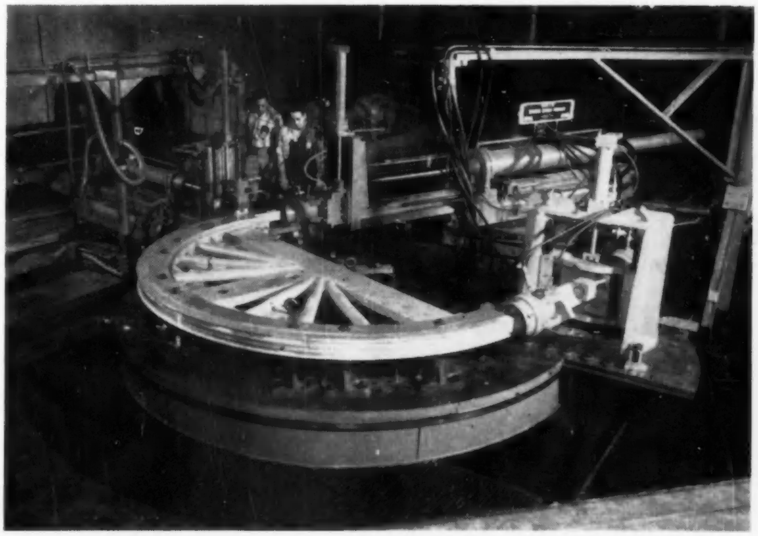
Small turbojets now being developed will have thrust-to-weight ratios as high as 10 to 1, Mr. Davis said. Large jet engines have a power-to-weight ratio of about 3 or 4 to 1.

Mr. Davis said that an engineering study group found that a small interceptor with several small turbojets would cost less than half as much as a large jet-engine plane designed for the same mission. Maintenance and operation costs, the study showed, would also be cut in half.

"The cold hard facts of economics in the design, production, and operation of turbojet aircraft dictate that we re-examine the problems created by our preoccupation with large engines," Mr. Davis said. "The universal application of the turbojet can be achieved only if the designer has available a wide variety of engines in small, medium, and intermediate thrust ratings."

KAMAN TO BUILD CRASH-RESCUE HELICOPTERS

Kaman Aircraft Corp. has received a multi-million dollar contract to produce crash-rescue helicopters for the Air Force. First deliveries call for Model H-43A machine powered by Pratt & Whitney piston engines, and later deliveries for H-43B helicopter, shown here, which is powered by Lycoming gas turbine engine.



BATH MACHINE TURNS OUT PARTS FOR JET TRANSPORT

Cyril Bath radial draw former, said to be largest in world, forms roughly semi-circular shapes by stretching them around a turntable-like form. Built for Convair Div. of General Dynamics Corp., the machine is used to turn out belt frames and wing bulkhead rails for the Convair 880 jet transport. Convair engineers say that these parts can now be designed with fewer components, thus resulting in more strength for less weight in the airplane and in more efficient production.

MEN IN THE NEWS

Allis-Chalmers Mfg. Co., Buda Div.—J. D. Harmison was appointed sales manager, material handling.

Micromatic Hone Corp. — Kirke W. Connor was elected chairman of the board, and Don S. Connor is now president and general manager.

Stewart - Warner Corp.—Arthur Collins has been elected a vice-president.

Westinghouse Electric Corp. — **Mark W. Cresap, Jr.**, was elected president; **E. V. Huggins**, chairman of the board's executive committee; and **John K. Hodnette**, executive vice-president.

E. I. duPont de Nemours & Co.—**Robert L. Hershey** was elected a vice-president and member of the executive committee, and **W. H. Salzenberg** was named to succeed him as general manager of the polychemicals department. **William H. Ward** has retired as a vice-president and executive committee member.

Ford Div., Ford Motor Co.—**L. A. Iacocca** was made car marketing manager, and **Wilbur Chase, Jr.** succeeds him as truck marketing manager.

Baker-Raulang Co. — **Richard T. Tiebout** has been appointed director of sales, and **Robert J. Laws** was named assistant director of sales.

LeMaire Tool & Mfg. Co.—**Lloyd Lee** was appointed director of automation.

Babcook & Wilcox Co.—**Robert P. Stuntz** has been appointed assistant sales manager of the Refractories Div.

Thor Power Tool Co.—**William J. McGraw** has been appointed general sales manager; **Walter G. Mitchell**, general manager of product development; and **Milton E. Slater**, sales manager of farm and ranch division.

General Motors Corp.—**Gerald M. Rassweiler** was named head of General Motors Research Staff's Physics & Instrumentation Dept., succeeding **Edward J. Martin**, retired.

International Harvester Co.—**W. C. Schumacher** has been elected an executive vice-president and member of the board of directors.

Sperry Rand Corp.—**James F. Toole** and **Charles Ondrick** were elected treasurer and controller, respectively.

Mack Trucks, Inc. — **Lowman T. Ohmart** was appointed director of industrial engineering.

Sharon Steel Corp. — **Henry G. Evans** was named general manager of operations; **William A. Horning**, general works manager at the Roemer plant; and **A. G. Neese** and **Charles W. Diven, Jr.**, assistant general sales managers.

Borg-Warner Corp., BJ Electronics —**Clifford B. Smith** was appointed sales manager.

Federal-Mogul-Bower Bearings, Inc. —**Richard L. Bracken** has become advertising manager of Federal-Mogul Service.

Jones & Laughlin Steel Corp.—**John J. O'Connor** has been promoted to manager — production planning, for the Stainless Steel Div.

Edsel Div., Ford Motor Co.—**Walter G. Curtis** was appointed public relations manager; **N. K. VanDerzee**, assistant general sales manager — field operations; and **W. S. Milton**, assistant general sales manager—marketing services.

Muskegon Piston Ring Co.—**Gilbert W. Lundeen** has been elected president, succeeding **Harold G. Vaughan**, who was named vice-chairman of the board. Other promotions include **G. Russell Targett**, vice-president and treasurer, and **Leonard H. Bazuin**, treasurer and assistant secretary.

Necrology

Thorsten Y. Olsen, 78, chairman of the board of Tinius Olsen Testing Machine Co., died Dec. 10.

Thomas Z. Fagan, 67, director of sales, service, and advertising of the Scintilla Div., Bendix Aviation Corp., died Dec. 6, at Sidney, N. Y.

Charles F. Beckwith, 70, a retired executive of A. O. Smith Corp., died Dec. 11, at New York City, N. Y.

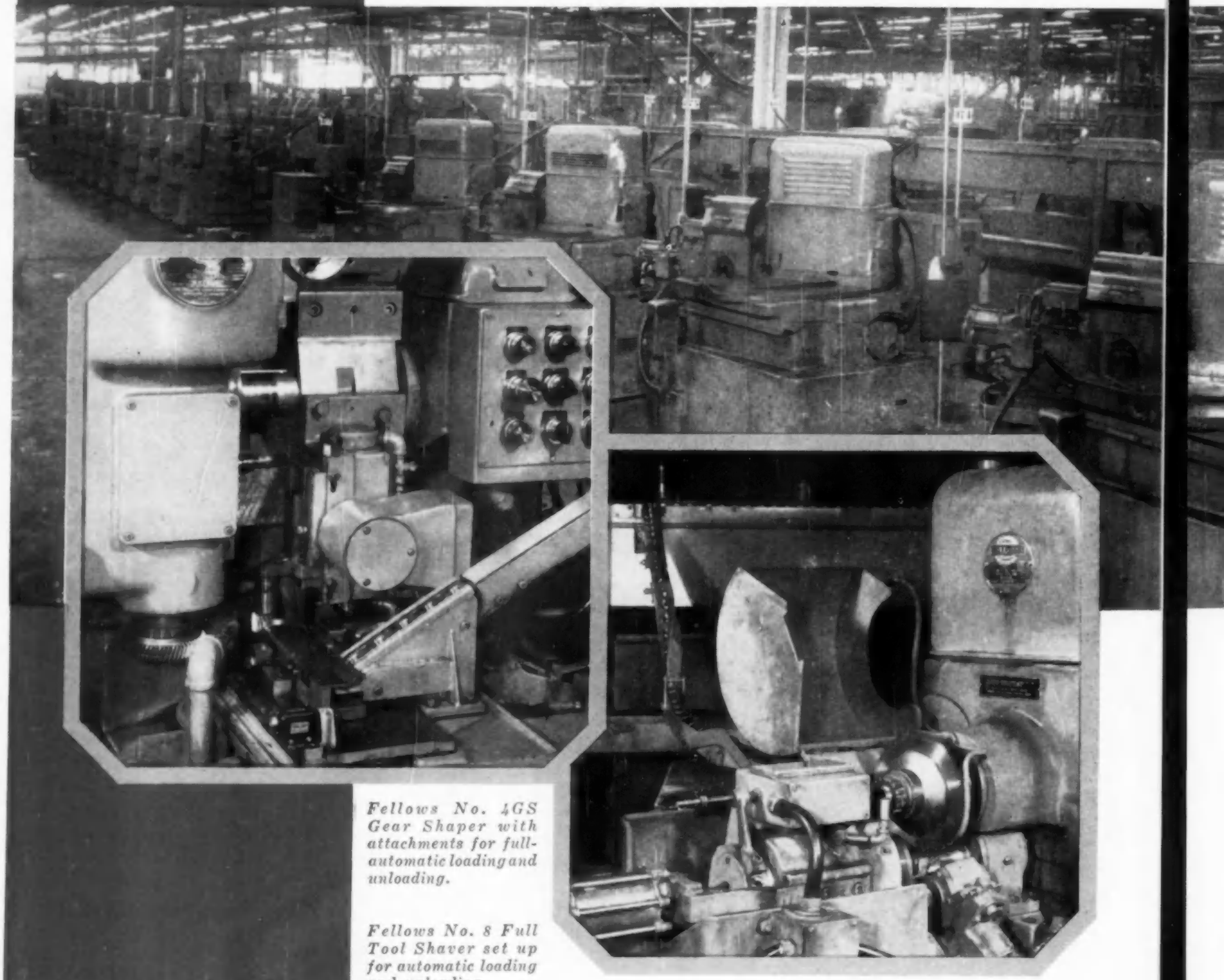
Henry J. Hoffman, 55, a vice president of Machlett Laboratories and of the Electronic Industries Association, died Dec. 11, at Stamford, Conn.

Edwin R. Bartlett, 74, retired president of Hooker Electrochemical Co., died Dec. 10, at Sarasota, Fla.

Eaton Mfg. Co., Stamping Div.—Robert B. Fisher has been named sales manager.

Latrobe Steel Co.—J. E. Workman has been appointed executive vice-president.

THE *FORWARD* LOOK...



Fellows No. 4GS Gear Shaper with attachments for full-automatic loading and unloading.

Fellows No. 8 Full Tool Shaver set up for automatic loading and unloading.

THE
PRECISION
LINE

How to squeeze more production from your automatic forging equipment ...at no extra cost

AUTOMATIC forging machines are no better than the uniformity of the steel you process. When structural or chemical changes occur in the steel you're using you have to interrupt operations to adjust your equipment. And you lose the continuous production you paid for!

You can avoid these interruptions by using uniform steel. Timken® electric furnace fine alloy steel, for instance. It's uniform from bar to bar, heat to heat, order to order.

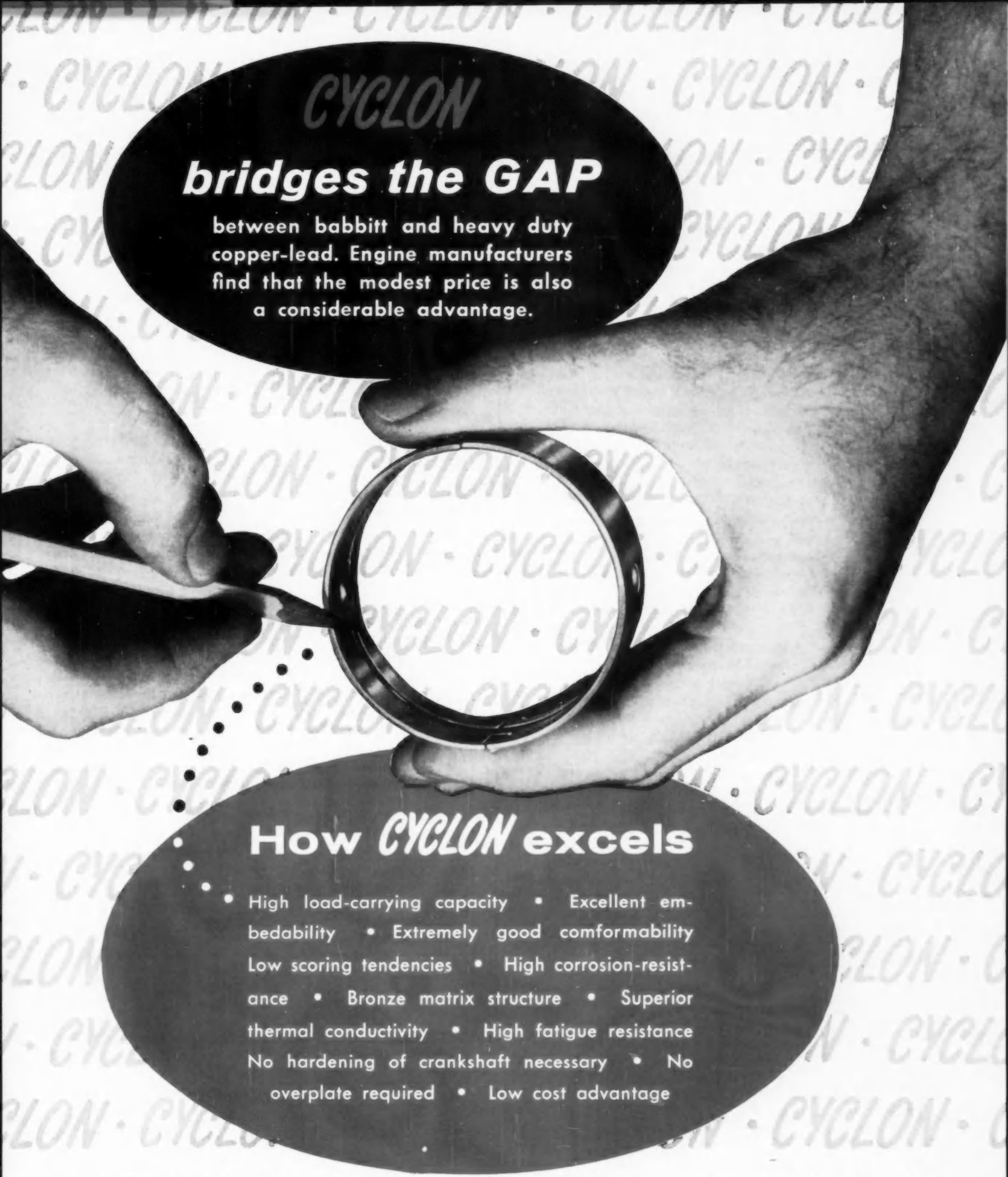
We take many extra quality-control steps to make sure it's uniform—many of them were American steel industry "firsts". For example, our magnetic stirrer for molten steel assures equal distribution of alloys, uniform temperature and working of the slag. A direct-reading spectrometer insures exactly correct composition to the very moment a heat is tapped. And individual order-handling assures uniformity that meets your own end-use requirements.

You'll squeeze the most production from your automatic forging equipment, at no extra cost, by specifying Timken fine alloy steel. You'll get uniform steel and faster, continuous production. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO".

TIMKEN *Fine Alloy* **STEEL**

TRADE-MARK REG. U. S. PAT. OFF.

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING



DETROIT ALUMINUM & BRASS CORPORATION

DETROIT 11, MICHIGAN

MANUFACTURERS OF ORIGINAL EQUIPMENT SINCE 1925

SOVIET MASTER PLANNING

APPARENTLY operating on a peacetime basis, Soviet industry actually is a huge military machine geared to mobilization. Since recovery of their nation from the ravages of World War II, the Kremlin Dictators have been directing a relentless drive in the industrial and scientific fields to outdo the United States and the other Free Nations. What progress the Soviets have made has been achieved by abandoning the theories of Communism and adopting perverted state capitalism with despotic rule. Through the years their goal has remained the same—Soviet Supremacy.

These special reports on Russian industries are a continuation of the series initiated 10 years ago by AUTOMOTIVE INDUSTRIES. They present the latest documented industrial information on that country, the result of many months of research work by specialists on the Russian economy. A list of the previous reports published by AUTOMOTIVE INDUSTRIES will be found on another page in this issue.

Brought into focus throughout these analyses is the warning—The Soviet challenge is ever present and will continue so. The Free Nations can not afford to ignore it, for otherwise the price will come dangerously high. Already wishful thinking has produced letdowns with damaging results.

Most of the material in these reports is about the automotive industries in Russia. They have long been the leading branch of the Soviet industrial machine and the incubator of mass production techniques for other industries. The automotive industries are a key group in Soviet industrial and military mobilization plans. This state-controlled program is being concentrated on these two fronts to weld together a Soviet economic bloc in Asia, Europe and Africa.

AUTOMOTIVE INDUSTRIES acknowledges the important contributions in this series made by the Foreign Manpower Research Office, U. S. Bureau of the Census.

The reports published here are summaries of comprehensive surveys prepared primarily by the Foreign Manpower Research Office for Government use. These FMRO surveys ordinarily would not have a wide public circulation and AUTOMOTIVE INDUSTRIES is pleased to make them available in condensed form.

Needless to say, the material provided by the staff of the Foreign Manpower Research Office does not represent in any way official positions or policies of the U. S. Government with respect to any of the topics discussed. The purpose of these reports is to present the facts and the personal views of the authors on these facts, and nothing more.

Three individuals have been most helpful in the preparation and organizations of the reports in this issue. Demitri B. Shimkin, of the Foreign Manpower Research Office and a recognized authority on the Russian economy, has served AUTOMOTIVE INDUSTRIES for years as Consulting Editor on Russian Industrial Affairs. During World War II he was an officer on the U. S. War Department General Staff. After the war Dr. Shimkin was associated for six years with the Russian Research Center at Harvard University, and since then has been with the Foreign Manpower Research Office. He has lectured on Russian Economic Potential and Strategic Logistics to the United States National War College, Industrial Col-

. . . SOVIET

THE study of Soviet industry presents formidable problems, for it differs profoundly in structure and methods of operation from industry in the West. These differences arise from two basic causes: unique configurations of natural resources, population, and intellectual traditions; and the cumulative effects of centrally dictated, intense effort focused on the achievement of maximum military-economic power. At the same time, other forces have acted as powerful agents of convergence toward patterns characterizing free-market economies. These forces include technological imperatives, such as the similar materials requirements of advanced consumers', producers' and military goods; the gravitation toward dynamic equilibrium inherent in every economy by virtue of the laws of marginal utility and diminishing returns; and the universal human propensity to pursue personal rather than collective goals. Finally, the conceptual difficulties thus inherent in the study of Soviet industry have been magnified, until recently, by a paucity of precise, reliable, and integrated information on the Soviet Union.

Because of these problems, a painstaking coverage of available information and a careful consideration of its statistical consistency and operational plausibility are especially important in research on Soviet industry. In general, operating systems rather than isolated phenomena must be investigated. Indeed, many facets of Soviet industrialization can be understood only in a very broad strategic, economic, and demographic context. Yet, the great differences between Soviet and Western patterns and the

INDUSTRIAL GROWTH—

Its Cost, Extent and Prospects . . . .

By Demitri B. Shimkin and Frederick A. Leedy

FOREIGN MANPOWER RESEARCH OFFICE

U. S. Department of Commerce
Bureau of the Census

kaleidoscopic alternations of advanced and retarded elements in the Soviet economy limit the opportunities for successful extrapolation from established facts. Systems of operation, structural elements and relationships, and trends over time can be delineated, but broad judgments and predictions are indeed hazardous. The waste and personal deprivation characterizing the Soviet economy are strikingly apparent, but how to weigh them against other types of economic and social losses often engendered by competitive, cyclical economies is not self-evident.

"Soviet Industrial Growth" outlines some results of studies of Soviet industry conducted by the Foreign Manpower Research Office, U. S. Bureau of the Census. It attempts to describe, insofar as concrete information permits, the economic and social costs of Soviet industrialization; the major achievements, the areas of relative failure, and the structural peculiarities apparently resulting from this effort; and prospects for further Soviet industrial growth. This paper rests upon a considerable body of statistical and technical evidence developed from primary sources of the past three decades, including the large amount of data released by the Soviet government during the last two years. The evaluation of this evidence is a continuing problem; in this report, some important formulations, such as the analysis of the Soviet steel balance, are still provisional and subject to appreciable error. This paper represents only its authors' information and interpretations; it in no way represents official positions or policies of the U. S. Government with respect to any topic discussed.

lege of the Armed Forces, Air War College, Naval War College and Marine Corps Schools.

Holland Hunter, Associate Professor of Economics at Haverford College, is a leading authority on Russian transportation systems. His background is given with his report in this series.

David Scott, London representative of AUTOMOTIVE INDUSTRIES, has made a number of trips in recent years to Russia and her satellites to inspect their automotive manufacturing facilities. He presents in this issue a revealing first-hand report on two Moscow automotive plants—JRC.

I Soviet Capital and Human Expenditures on Industry

DURING the last 30 years the Soviet Union has taxed itself, by plan, to expand its industry and enhance its military-economic power. It has pursued these goals by great expenditures of capital and human effort, including the organization and large scale support of specialized educational and research institutions, often to the detriment of those sectors of the economy which were relegated to lower orders of priority. As a result, there appears to be a mixed bag of achievements and failures. On the positive side, for example, there has been a perpetuation and marked development of the Tsarist systems of elite education, military education, and research. There is no doubt that these institutions have contributed to the strengthening of Soviet strategic security. Conversely, there have been such adverse effects as the underinvestment in agriculture resulting from the over-riding demands of the industrialization program. This, in conjunction with poor organization and coercive policies toward the peasant, has held the Soviet output of food and fibers to levels far lower than Western per capita supplies.

Also, the scale of Soviet industrial growth and the concentration of industrial output (a concentration induced by efforts to gain economies of scale, by perennial shortages of supervisory personnel, and by the elemental character of the Soviet transportation network) have brought

This report was prepared with the assistance of Murray Feshbach, Lydia W. Kulchycka, and Barney K. Schwalberg, Foreign Manpower Research Office, U. S. Bureau of the Census. This paper is a condensation of an annotated report available to specialists by application to the U. S. Bureau of the Census.

about intensive urbanization. The Soviets have been unable to cope with the numerous problems accompanying rapid large-scale urbanization, but this is more a matter of the priority given to these problems than it is a reflection of total indifference. Thus, the large Soviet construction industry, although committed to support industrial and military programs, as a matter of first priority, has devoted considerable resources to residential housing. During the past decade the residential-building program of the USSR was about 40 per cent as great, in terms of floor space, as that of the United States. Yet, this program has provided an average of only some 50 sq ft of floor space per city dweller or about one-sixth the U. S. average. It has also led to inadequate attention to pressing needs for school-room construction, so that, in 1955/56, a decade after World War II, and at a time when school attendance had already dropped 15 per cent from the 1950/51 peak, 37 per cent of all Soviet pupils were attending double-session or triple-session schools.

With this general framework in mind, a more detailed examination of the scale and pattern of Soviet industrial investment, energy allocation, and manpower utilization appears worthwhile.

a. Capital Investment

Soviet industrialization has been accompanied by a decreasing proportion of total output going to consumers. In 1928, consumers' goods and the production of energy for household consumption comprised 59 per cent of the nation's industrial output. By 1940, this share had dropped to 37 per cent; since World War II, it has been further reduced to 27 per cent (Table I). (For the United States, a single comparative figure, 64 per cent in 1947, is available.) Thus the great bulk of Russia's manufactured goods has gone into capital investment and armaments.

According to Soviet statistics, the share of industry in total investment has risen from 41 per cent prewar to an average of 50 per cent since 1946; more than 85 per cent of industrial investment, furthermore, has gone to producers' rather than consumers' goods industries. Construction has accounted for over two-thirds of Soviet investment. Its absolute scale has been very large. Specifically, the area of industrial floor space built in the USSR between 1929 and 1956 has about equalled the area of manufacturing floor space built in the United States over the same period, roughly 2.9 billion sq ft. In fact, between 1929 and 1940, the Soviets built 40 per cent more industrial floor space than did the United States. Since 1951, the two countries have each constructed about one billion sq ft.

Large-scale industrial construction in the Soviet Union has been made possible by a rapid expansion of building-materials output, especially the production of cement and bricks; by the allocation to industry of over 30 per cent of the national construction effort—roughly the World War II proportion in the United States; and by radical economies in the use of steel. The Soviet output of construction types of hot-rolled iron and steel (excluding rails and splice bars) increased sevenfold during 1928/56, and by about 75 per cent between 1950 and 1956. This increase, although very impressive, was dwarfed by the growth of production of the most important of Soviet industrial building materials, namely cement and bricks. In the last 30 years, cement production has increased fourteenfold and brick production eightfold; since 1950 the production of these materials has increased by 144 per cent and 187 per cent, respectively. The relative shortage of steel has made ponderous, labor-consuming, wall-bearing construction customary even in industrial design. In 1953, for example, steel-frame construction comprised only 35 per cent of the industrial floor space built by the USSR Ministry of Construction.

To minimize expenditures and labor in construction, the Soviets have paid considerable attention to the utilization of precast concrete blocks, panels, and stair units, components which are lifted into place by on-site cranes. Even more significant as restraints to undesired construction, both industrial and non-industrial, have been extensive direct controls and limitations upon the use of materials, labor, and funds.

The Soviet input of producers' durables into industry has been nearly as spectacular as their building program. Of course, the scale has been limited by the absolute size of Soviet metal production, which even in 1955 constituted only the following proportions of U. S. output: rolled iron and steel, 41.5 per cent; cast iron, 37.2 per cent; refinery copper, about 24 per cent; and primary aluminum, about 35 per cent. Also, a substantial part of the Soviet metal supply has had to go to construction, and minimal shares have gone to repair, new transportation equipment, agricultural machinery, and consumers' goods. In the late prewar years, and again after 1950, military end-items (including shipping) received a quarter or more of the nation's rolled iron and steel supply. Nevertheless, the growth of steel consumption for industrial machinery, equipment and metalwares has been vigorous: from a negligible level in 1928 to about 1.5 million metric tons in 1937 and 7.5 million metric tons in 1956. The last figure corresponds to about 72 per cent of American rolled iron and steel consumption, for the same purposes, in that year. This proportion (adjusted for differences in the utilization of cast iron and alloy steels, and in metalworking practice, in the two countries) implies that, in 1956, Soviet *production* of installed industrial equipment was about two-thirds as great as that of the United States.

The relative quantity of Soviet industrial equipment *on hand* appears, however, to be appreciably smaller—about 40 per cent of the United States level today. One reason for this difference lies in the fact that both World War II and the Korean War brought about large-scale industrial investment in the United States. In contrast, World War II brought devastation to much of the USSR, while during the Korean War, Soviet resources were too limited to manage accelerated arms production and rapid industrial expansion simultaneously (see also Table I).

The best available measure of industrial equipment in operation is found in recent official statistics on the horsepower of equipment installed in Soviet industry. This grew from 4.0 million horsepower in 1928, to 22.6 million in 1940, and to 77.3 million in 1956. Virtually comprehensive data by branch of industry permit the attribution of about 11 per cent of the 1956 capacity to atomic-energy installations. Comparable figures for the United States, excluding atomic energy, are 48.2 million horsepower in 1929, 63.9 million in 1939, and 150.7 million in 1954. Thus,

EXTRA COPIES of these Soviet industry reports can be obtained until the supply is exhausted by writing to Readers Service Dept., AUTOMOTIVE INDUSTRIES, Chestnut & 56th Sts., Philadelphia 39, Pa. Also available for free distribution is a limited supply of the prophetic article, "Rockets Behind the Iron Curtain," which was published in the January 1, 1954 issue of AUTOMOTIVE INDUSTRIES

TABLE I

Commodity Group and Measure	1928	1934	1937	1940	1948	1950	1951	1952	1953	1954	1955	1956
All Industry, Index, 1934 = 100	57.3	100.0	157.1	168.6	168.2	248.6	288.1	309.1	341.8	377.5	409.5	443.1
Index, 1950 = 100	23.1	40.2	63.2	67.8	67.7	100.0	115.9	124.3	137.5	151.8	164.7	178.2
Man-Year Productivity of Industrial Wage Workers, Index, 1934 = 100	90.4	100.0	128.9	120.3	113.7	144.3	158.8	165.4	175.0	182.8	193.0	204.1
Index, 1950 = 100	62.7	69.3	89.3	83.3	78.8	100.0	110.0	114.6	121.2	126.7	133.8	141.4
	Percent Distribution of Industrial Output											
All Industry	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Of which,												
Consumers' goods and supply[1]	59.5	39.2	37.1	37.4	26.0	27.1	26.9	26.6	26.7	27.0	26.9	26.5
Producers' and military goods and supply[2]	40.5	60.8	62.9	62.6	74.0	72.9	73.1	73.4	73.3	73.0	73.1	73.5
Of which,												
Machinery and equipment	12.4	19.8	25.8	23.1	30.2	33.5	35.4	35.2	35.7	35.6	34.9	36.0
Military end-items[3]	3.4	4.1	8.5	10.2	8.4	5.4	10.9	11.2	9.9	9.6	8.4	8.9
Producers' goods and military components[4]	8.1	14.4	15.7	12.1	21.1	26.0	22.3	21.7	23.2	23.0	23.2	23.5
Civilian durables[5]	0.9	1.3	1.6	0.8	0.7	2.1	2.2	2.3	2.6	3.0	3.4	3.5
Metals	7.1	10.3	11.1	11.7	12.8	12.8	12.8	13.6	13.8	13.9	14.5	14.4
Wood products and nonmetallic building materials	11.1	14.0	11.5	10.2	10.0	9.7	9.6	9.4	9.0	9.1	9.1	8.8
Energy, chemicals and rubber	16.2	24.8	21.7	25.0	25.9	23.2	21.4	21.2	20.8	20.9	21.5	21.4
Textiles, apparel and footwear	21.7	15.5	15.3	16.3	11.7	11.3	11.8	11.5	11.5	11.6	11.3	10.7
Food products	31.5	15.6	14.6	13.7	9.4	9.5	9.1	9.1	9.2	8.9	8.7	8.7

[1] Includes all textiles, apparel and footwear; all food products; all consumers' durables (domestic sewing machines, electric light bulbs, bicycles, motorcycles, and half of passenger-car output); soap; rubber footwear; and the household-consumption share of fuel and electrical-power output.

[2] Includes all other commodities covered.

[3] Calculated from rolled-steel balances.

[4] Producers' Goods and Military Components: steam boilers; industrial and marine engines; power shovels; machine tools (by type); rolling-mill equipment; textile machinery (by type); tractors in 15-horsepower units; agricultural machinery; locomotives; freight cars; railroad passenger cars; railway cranes; passenger autos (one-half) and trucks; telephones; and power transformers.

[5] Consumers' durables: see note 1.

Sources: TsS.U.: *Promyshlennost' SSSR (Industry of the U.S.S.R.)*, Moscow, 1957; and National Bureau of Economic Research: *Statistical Abstract of Industrial Output in the Soviet Union, 1913-1955* (5 vols.), New York, 1956. Methodology of 1934 Soviet value-added weighting, a modification of D. R. Hodgman: *Soviet Industrial Production 1928-1951* (Harvard University Press, 1954). For further details see D. B. Shimkin, M. Feshbach and F. Manning: "Estimates of Soviet Industrial Production, 1928-1956," FMRO, U. S. Department of Commerce, Bureau of the Census (November 7, 1957); and a forthcoming monograph by D. B. Shimkin, F. A. Leedy and L. Kulchycka on Soviet industrial manpower.

TRENDS IN SOVIET INDUSTRIAL OUTPUT, MEASURED IN SOVIET 1934 VALUE-ADDED WEIGHTS: SELECTED YEARS, 1928-1956

the installed capacity of Soviet industrial equipment, atomic energy apart, has grown from barely eight per cent to more than 40 per cent of the U. S. level over the past 30 years. The distribution by type of installed equipment is quite different in the two countries. On January 1, 1957, the Soviet Union had an inventory of 1,840,000 machine tools, 80 per cent of the number in the United States in late 1953. The Soviet inventory of metal-forming equipment totalled 385,000 units, or 58 per cent of the American number. The large disparity in other types of equipment (conveyors, blowers, pumps, servo-mechanisms, etc.) which is indicated by the data on the total horsepower of equipment and the inventories of metal-processing units points out an essential contrast in the manufacturing technologies of the two countries.

b. Energy Consumption

The Soviet Union has rapidly expanded its production of energy from mineral fuels, fuelwood, and hydroelectric power, from about 1.7 quadrillion Btu in 1928 to 6.6 quadrillion in 1940, and to 13.6 quadrillion in 1955. Over these years, Soviet energy output has increased from about 8 per cent to 34 per cent of the heat value of American mineral fuel and hydroelectric production alone. Fragmentary information indicates the following approximate distribution of Soviet energy consumption in 1955: industry, 40 per cent; transportation, 25 per cent; households, 20 per cent; agriculture, 5 per cent, and other, 10 per cent. The American pattern in 1947 was not radically different: 33 per cent of all energy went to industry (including nonfuel uses); 31 per cent, to transportation; and the rest to domestic, commercial, and other uses. Of course, freight dominates Soviet transportation; passengers are far more important in the American system than in the Soviet. Nevertheless, it is clear that despite minimal attention to transport and consumer needs in a large and cold country, these requirements have limited total Soviet energy utilization in industry.

For many years, the industrial consumption of electrical power in the Soviet Union has taken three-quarters of national output, less station and line losses. It rose from 3.3 billion kwh in 1928 to 32.1 billion in 1940, and to 113.3 billion in 1955. In that year, industrial power consumption in the United States approximated 355 billion kwh, including some 60 billion by the Atomic Energy Commission. This constituted two-thirds of American electrical-power output, less losses.

Two features of the Soviet industrial utilization of electricity are significant. First, the proportion attributed to major electro-processes was 17 to 18 per cent in 1937-40. It reached 23.2 per cent in 1950 and 26.4 per cent in

1955. The comparable American proportion, excluding atomic energy, was 18.9 per cent in 1950. Given present knowledge of Soviet technology, it appears safe to allocate 10 to 15 billion kwh from 1955 industrial consumption to atomic energy. Second, the industrial consumption of electricity (excluding that going to atomic-energy programs) is barely 35 per cent of the corresponding American quantity. Yet the horsepower of equipment installed is over 40 per cent as great as the American, and is operated on a multi-shift basis. Thus, differences in composition, maintenance levels, and other factors have been reflected in differences in industrial capital productivity.

c. Manpower Utilization

A discussion of all the intricacies involved in Soviet manpower utilization is beyond the scope of this paper. Nevertheless, six aspects of this complex problem are most relevant to understanding Soviet efforts and costs in industrialization.

FIRST, industrial output has been expanded largely by increasing labor inputs. Between 1928 and 1940, employment in industry rose from 5.6 million man-years to 16.7 million, climbing to 22.7 million in 1956 (Table IV). This is a fifth higher than the comparable figure for the United States.

SECOND, industrial employment plus other labor directly serving industry (about 30 per cent of that in construction, and 60 per cent of that in transportation) have provided about two-thirds of all urban employment. In other words, Soviet urbanization has been accompanied by little expansion of consumer services over the past 30 years. This contrasts sharply with Western trends.

THIRD, differential pay, reinforced by the conscription of adolescents via the State Labor Reserves, and of adults via the *nabor* (draft) system, have led to a selective drain of agricultural labor. In consequence of this drain and of male population losses during World War II, able-bodied males constitute less than 40 per cent of all Soviet adult farm workers. The proportion of adult agricultural workers with a fifth-grade education or higher is about 20 per cent; the proportion with higher or technical education, 0.8 per cent.

FOURTH, Soviet education has been largely directed toward the needs of industrial and other operating agencies. Even in 1955/56, university enrollment constituted only 13.5 per cent of the total for higher education, the remainder being in technical institutes of narrow specialization. In primary and general secondary education the Soviet Union has stressed scientific and technical training in the higher grades, to the appreciable disadvantage of schooling in the primary grades. Official Soviet statistics for 1955/56 show that, while 50.4 per cent of all Soviet teachers, principals and supervisors had either a university or normal-school higher education, and while 80 per cent of the science and mathematics teachers had such training, 96.6 per cent of the teachers of primary grades had only a secondary or even seven-year education. Because of this fact, because of curricula unadapted to variations in ability, and because of economic pressures to leave school, Soviet failure and drop-out rates are high. In 1954/55, only 80 per cent of the children enrolled at the beginning of the year either graduated or were promoted at the end of the year. This retardation rate has been a major factor in holding down average educational attainment in the USSR. In 1956, only one-third of the industrial workmen—a young and select lot—had a seventh-grade education or more. Among the consequences of this low educational level have been a need for excessive job simplification and a low level of labor productivity.

FIFTH, the system of academies and universities which Russia has developed for more than 200 years has undoubtedly been significant in promoting innovation, and in maintaining a training ground for the intellectual elite. Research has long been stressed; as early as 1936, the Soviets employed 303,000 persons in research, geological survey, and planning units. The comparable figure in 1956 was about 470,000. The heart of this research effort has been the *Akademiya Nauk*, Academy of Sciences, which is today the largest research body in the world, with 15,716 professional employees. The specialized military institutions, such as the Academy of Artillery Sciences, have long promoted the close coordination of strategy, tactics, and technology. The civilian economy has not fared as well; even today, for example, the USSR lacks a single automotive proving ground.

SIXTH, labor-force participation rates have been maintained at very high levels in the USSR since 1926 (Table IV) through economic pressures upon low-paid workers and through incentives for professionals created by low taxes and cheap domestic help. In contrast, the problem of job mobility and turnover has been a troublesome one, particularly in regard to professionals. Thus, data from the Soviet professional manpower survey as of December 1, 1956, show substantial movements out of the physical sciences and engineering. Although 721,000 persons then employed had degrees in those fields, not more than 590,000 of them, or two-thirds the corresponding American number, were still active in production or research (Table II).

This, then, has been the Soviet industrialization effort. In intensity, duration and scope, it has exceeded that of any other nation. What results has it gained?

II Accomplishments, Weaknesses, and Characteristic Features of Soviet Industry

THE immense industrialization effort of the Soviet Union has resulted in important successes, particularly in the field of military production. Its major failure has been the wasteful use of human and physical resources. Moreover, by long persistence in a drive for maximum total output with a minimum of internal competition or even coordination, it has created an industrial structure characterized by the co-existence of giant plants and minuscule shops, of advanced and handicraft technologies. The dynamic features of this structure and its input-output relationships, are, of course, far different from those of American industry. Hence, if comparisons with the United States are to be made, American yardsticks should be applied with caution in the assessment of Soviet industry.

a. Accomplishments

Soviet successes in military technology long antedate the sputnik. In 1936, the Soviets conducted the world's first paratroop maneuvers. In the years 1937-39, they designed a modern family of field artillery, utilizing ballistically advanced projectile designs developed by their laboratories in the early 1930's. During World War II, the Soviets, despite grievous war losses but with the aid of substantial lend-lease raw-materials and supplies, were

TABLE II

(Numbers in thousands)
(Figures in parentheses ( ) are estimates)

Economic Branch	In Which Trained: Total (1)	In Which Trained: Professional Level (2)	In Which Trained: Subprofessional Level (3)	In Which Employed: Total (4)	In Which Employed: Professional Level (5)	In Which Employed: Subprofessional Level (6)	Apparent percent of change from branch of training to branch of employment: Total (4) ÷ (1) (7)	Apparent percent of change: Professional Level (5) ÷ (2) (8)	Apparent percent of change: Subprofessional Level (6) ÷ (3) (9)	Professionals and subprofessionals as percent of employment in economic branch: Of Total Employment[1] (10)	Of Technical Employment Only[1] (11)	Of Which Professionals[1] (12)
Total, civilian sector	6,252.8	2,631.2	3,621.6	6,257	2,633	3,624	—	—	—	7.0	n.a.	n.a.
I. Industry and allied	1,770.6	720.9[2]	1,049.7	1,286	428	858	−27.4	−40.6	−18.3	3.8	50.0	16.7
1. Industry	(1,429.8)[3]	(592.7)[3]	(837.1)[3]	950	320	630	−23.6	−36.9	−14.1	4.2	58.0	19.5
2. Construction				143	54	89				2.7	42.6	16.1
3. Transportation and communications	(340.8)[3]	(128.2)[3]	(212.6)[3]	193	54	139	−43.4	−57.9	−34.6	3.4	32.3	9.0
II. Agriculture and forestry	474.9	179.5	295.4	360	98	262	−24.2	−45.4	−11.3	0.8	95.7	26.1
III. Economics, trade and law	472.5	197.7	274.8	600	269	331	+27.0	+36.1	+20.5	10.3	n.a.	n.a.
1. Economics and economic statistics	335.1	130.2	204.9	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
2. Trade	57.9	11.0	46.9	122	28	94	+110.7	+154.5	+100.4	4.1	n.a.	n.a.
3. Law	79.5	56.5	23.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
IV. Education and propaganda	2,050.7	1,116.6	934.1	2,540	1,422	1,118	+23.9	+27.4	+19.7	53.5	88.1	49.3
1. Research and higher education	([4])	([4])	n.a.	449[5]	291[5]	158[5]	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Incl. natural sciences	([4])	([4])	n.a.	n.a.	(162)[6]	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
2. General primary and secondary education	n.a.	n.a.	n.a.	(1,775)[7]	(913)[7]	(862)[7]	n.a.	n.a.	n.a.	n.a.	(98.0)[8]	(50.4)[8]
Incl. natural sciences	n.a.	n.a.	n.a.	(324)[7]	(260)[7]	(64)[7]	n.a.	n.a.	n.a.	n.a.	(100.0)[9]	(80.2)[9]
3. Other schools	n.a.	n.a.	n.a.	(269)[10]	(185)[11]	(84)[11]	n.a.	n.a.	n.a.	n.a.	(100.0)[9]	(68.8)[9]
4. Libraries, propaganda, entertainment and other	n.a.	n.a.	n.a.	(47)[12]	(33)[11]	(14)[11]	n.a.	n.a.	n.a.	n.a.	(8.2)[13]	(5.8)[1]
V. Health and physical education	1,229.6	329.4	900.2	1,152	284	868	−6.3	−13.8	−3.6	41.4	83.7	20.6
VI. Other	254.5[14]	87.1[14]	167.4[14]	319[15]	132[15]	187[15]	+25.3	+51.5	+11.7	n.a.	n.a.	n.a.

*Professionals are graduates of institutions of higher learning; subprofessionals are graduates of vocational schools at the high school to junior college level.

n.a.—Data not available.

[1] Employment data are from table IV; Ts.S.U. *Dostizheniya sovetskoy vlasti za 40 let v tsifrakh (The Accomplishments of the Soviet Regime over 40 Years, in Figures)*, Moscow, 1957, pp. 51, 219, 255, and 274; and Ts.S.U., *Narodnoye khozyaystvo SSSR v 1956 godu (The National Economy of the U.S.S.R. in 1956)*, Moscow, 1957, pp. 204-5.

[2] This category includes *all* Soviet engineers and physical scientists, whether trained in technical institutes or universities. Compare Ts.U.N.Kh.U., *Kul'turnoye stroitel'stvo SSSR (Cultural Construction of the U.S.S.R.)*, Moscow, 1940, p. 112, and Ts.S.U., *Kul'turnoye stroitel'stvo SSSR (Cultural Construction of the U.S.S.R.)* Moscow, 1956, pp. 214-217.

[3] Allocated between industry and construction, and transportation and communications on the basis of the relative totals of graduates over the years 1933-55, inclusive. Cf. *Kul'turnoye stroitel'stvo . . .*, 1956, *op.cit.*, pp. 216, 240.

[4] The total number of advanced degrees awarded in the U.S.S.R. during 1925-1956, inclusive, is 79,600, about 34,900 of these being in engineering and the physical sciences. See *Kul'turnoye stroitel'stvo . . .*, 1956, *op.cit.*, pp. 256-258; *Narodnoye khozyaystvo . . .*, *op.cit.*, p. 260, and N. DeWitt, *Soviet Professional Manpower*, Washington, National Science Foundation, 1955, p. 338.

[5] Includes personnel in research, higher education, planning, design, and geological survey, cf. *Dostizheniya*, *op.cit.*, p. 260. The 1956 number of professionals employed in higher education and research alone was 239,900 (*ibid.*, p. 284).

[6] Estimated by allotting all professionals (51,000) in planning, design, and geological survey work to the physical sciences, and by ascribing the 1955 proportion in physical sciences to the remainder. See *Kul'turnoye stroitel'stvo . . .*, 1956, *op.cit.*, p. 250.

[7] The proportions directly reported for the school year 1955-56 (*Kul'turnoye stroitel'stvo*, 1956, *op.cit.*, pp. 178-181) have been applied to the 1956-57 total of 1,811,000 teachers, principals, and supervisors (*Dostizheniya*, *op.cit.*, p. 274). Note that normal school graduates constitute 53.7 percent of all Soviet professional-level teachers, and 19.8 percent of those teaching the natural sciences (including mathematics).

[8] For technical employment figure see *Dostizheniya*, *op.cit.*, p. 274.

[9] Technical employment in this field assumed to be totally professional or subprofessional.

[10] Number in "other schools" by subtraction of those in "general education" from the total, cf. *Dostizheniya*, *op.cit.*, pp. 255 and 274.

[11] Number of professionals and subprofessionals in the categories "other schools" and "libraries" by subtracting "general education" from the total, cf. *Dostizheniya*, *op.cit.*, p. 260. Distribution of this residual between "other schools" and "libraries" assumed to be the same as that for total employment, i.e., 85.1 percent in "other schools."

[12] Residual obtained by subtracting "general education" and "other schools" from the total, cf. *Dostizheniya*, *op.cit.*, p. 260.

[13] For technical employment figure see *Dostizheniya*, *op.cit.*, p. 255.

[14] Residual. Probably includes graduates of Communist Party and Military Schools now in civilian employment.

[15] Residual. Includes employment in communal housing, trade union officials, etc.

Sources: Ts.S.U., *Narodnoye khozyaystvo SSSR v 1956 godu (The National Economy of the U.S.S.R. in 1956)*, Moscow, 1957; Ts.S.U., *Dostizheniya sovetskoy vlasti za 40 let v tsifrakh (The Accomplishments of the Soviet Regime Over 40 Years, in Figures)*, Moscow, 1957; Ts.S.U., *Kul'turnoye stroitel'stvo SSSR (Cultural Construction of the U.S.S.R.)* Moscow, 1956; N. DeWitt, *Soviet Professional Manpower*, Washington, National Science Foundation, 1955; and Ts.U.N.Kh.U., *Kul'turnoye stroitel'stvo SSSR (Cultural Construction of the U.S.S.R.)*, Moscow, 1940.

THE TRAINING AND DISTRIBUTION OF SOVIET PROFESSIONAL AND SUBPROFESSIONAL MANPOWER* IN DECEMBER 1956 (EMPLOYED CIVILIANS ONLY)

second only to the United States in munitions output. Soviet tanks and self-propelled guns introduced basic advances in track design, suspension, armor configuration, and armament. These advances were copied in the German Panther and Tiger tanks, and are incorporated in present-day American armored vehicles. Soviet 120 mm mortars were copied by the Germans; Russia's wheeled 160 mm mortar, introduced near the end of World War II, had the bursting power of eight-inch shells, and gave powerful, mobile support to armored columns. The Soviet 132 mm ground-to-ground rockets, fired in target-saturating ripples, were especially feared by the Germans. Finally, the Soviets solved many production problems. A notable instance was the mastery of projectile casting even

THE memory of highly creditable Soviet war production between 1941 and 1945, coupled with postwar economic growth, and with Soviet capabilities of seizing the productive plants of Continental Western Europe, forbids complacency towards the potential military challenge of Russia's economy.—from "What Is Russia's Industrial Strength?" by D. B. Shimkin in August 15, 1950, issue of AUTOMOTIVE INDUSTRIES

IN all, an intense armaments effort is the outstanding characteristic of the Soviet economy today. Despite recent concessions to the consumer, no major relaxation of this effort is in sight.—from "Russia's Strength Today" by D. B. Shimkin in October 1 and 15, 1953, issues of AUTOMOTIVE INDUSTRIES

for armor-piercing rounds, a technique which reduced serious bottlenecks in rolling and machining equipment.

During the difficult recovery period of 1945-1950, Soviet armaments accomplishments included the atomic bomb, mass production of jet fighters and light bombers, and the full motorization of their army. In 1951, their effort was sharply increased; it has continued to grow since (Table I). Post-Korean accomplishments have included the hydrogen bomb, high-performance jet bombers, large-scale production of submarines and cruisers, and re-equipment of the army with advanced weapons, including the powerful T-54 tanks, high-capacity helicopters, and an entire family of missiles.

Apart from direct military production, Soviet industry has concentrated investment and skills in selected branches of production, notably machine tools. The desire for self-sufficiency in tooling, the specific needs of Soviet ordnance, and weaknesses in other aspects of metal-working (rolling mills, centrifugal casting, metal-forming, etc.) have resulted in a large scale machine-tool output of unique composition. By 1956, the Soviet Union was matching the current volume of United States machine-tool production, although not the American peaks of World War II and the Korean War (Table III). In planers, shapers, and drilling machines Soviet output far exceeds the American, but it is far lower in grinding and polishing tools. Soviet machine tools are comparatively cheap; in buying them, the Soviet ruble is worth 30 to 50 U.S. cents, compared to 10 cents for most commodities.

This cheapness largely reflects economies of scale and organization rather than deficiencies in product quality, although some are evident. For example, Soviet machine tools are generally heavier than their American counterparts; they use bronze or babbit rather than anti-friction bearings, and iron rather than steel gears, both of which tend to reduce machine speeds and life; and they rarely have automatic controls and quick-change features. Also, the Soviets complain of the short life of their cutting carbides.

Despite such deficiencies, however, the large volume of production of relatively low cost machine tools is a very creditable accomplishment of Soviet industry.

Yet the successes of the Soviet machine-tool industry have led to a series of paradoxes. First, expansion in the number of Soviet machine-tools in use has been so rapid that even present large-volume production is insufficient to replace tools more rapidly than after 15 to 18 years of service. The actual replacement rate has been only two to three per cent per year. Modernization has been a partial substitute for replacement, with some 60,000 tools modernized during the past decade. Second, machine-tool technology has advanced far beyond that of supplier operations. Thus, much potential capacity of the machine tools remains idle because these supporting operations cannot keep pace with machine-tool requirements. In Soviet words,

> "At present, machine tools are in actual operation only from 25-35 per cent of the maximum shift time." [*Promyshlenno-ekonomicheskaya gazeta (Industrial-Economic News), November 2, 1956.*]

This backwardness of auxiliary operations reduces the effectiveness of major redesigns of cutting equipment. To date, Soviet process modernization has largely consisted of the creation of automatic lines of standard machine tools. In 1956, the Soviets claimed to have about 100 such lines in operation; the adoption of continuous-production technology in shaping operations is even less developed. Specialized high-capacity tools play a small role even in Soviet anticipations, for the scale of production is generally too small, special equipment—especially instrumentation—is too scarce, and research and development for civilian needs are too expensive.

A final, major area of Soviet success has been in the expansion of over-all industrial output. Soviet industrial production in 1956 was 7.7 times as great as in 1928, 3.8 times as great as in 1940, and 78 per cent higher than in 1950 (Table I). While this growth has largely supported armaments and investment, its magnitude has been great enough to assure a growing supply of fabricated consumers' goods—e.g., canned goods, bathtubs, and radios—particularly since 1950. The quantities produced are modest, but they are vital as incentives to industrial workers and the Soviet elite.

b. Weaknesses

The successes of Soviet industrialization have been purchased at heavy cost, in terms of both labor and capital. Moreover, the unbalanced pattern of industrial development, with its emphasis on military end items and capital equipment for industry, has deprived the Soviet population generally of many necessities and amenities. Other consequences of Soviet industrialization are a relative weakening of other branches of the economy, notably agriculture, and a disadvantageous redistribution of industrial costs in the form of differential increases in raw materials prices. In manufacturing operations, expanded production has led to economies of scale, and technological advances have also reduced unit costs; but unit costs of agricultural commodities have not declined apace. Thus, in 1955 raw materials costs comprised 65.6 per cent of

TABLE III

Item	U.S.S.R. 1928	U.S.S.R. 1937	U.S.S.R. 1940	U.S.S.R. 1950	U.S.S.R. 1955	U.S.S.R. 1956	United States 1927	United States 1939	United States 1947 (shipments)	United States 1956 (shipments)
I. Units produced, total	1,978	48,473	58,437	70,597	117,087	121,300	n.a.	n.a.	n.a.	n.a.
A. General purpose machine tools†										
1. Lathes and turret lathes	830	17,902	15,650	26,405	35,641	(35,322)	11,067	n.a.	32,320	25,140
Of which, turret lathes	—	1,806	2,088	1,402	2,825	(2,800)	1,776	n.a.	1,573	3,013
automatic lathes	—	894	2,039	863	1,524	(1,510)	—	n.a.	1,099	1,680
2. Planers, shapers, and slotters	216	3,725	2,379	2,883	4,517	(4,476)	1,218	n.a.	1,970	n.a.
Of which, planers	146	303	173	218	453	(449)	196	161	152	133
shapers	35	3,172	2,048	2,561	3,559	(3,527)	986	1,163	1,787	671
3. Gear-cutting and finishing machines	—	397	543	1,658	1,973	(1,955)	1,267	1,730	1,682	2,175
4. Broaching machines	—	44	68	179	307	(304)	255	470	532	524
5. Boring machines	—	131	124	227	643	(637)	598	791	781	1,068
6. Drilling machines	546	12,820	15,861	10,759	26,921	(26,679)	5,813	n.a.	19,709	16,443
7. Milling machines	53	3,243	3,701	3,857	7,339	(7,273)	2,650	n.a.	5,749	10,858
8. Grinding and polishing machines	333	9,249	13,423	15,868	23,061	(22,854)	8,282	n.a.	109,557*	n.a.
9. Sawing and cut-off machines	—	—	—	138	—	(—)	2,056	n.a.	20,864**	18,921
B. Special, multi-spindle and transfer tools	(not reported separately)	962	6,688	8,623	16,685	21,800	3,216	n.a.	7,983	9,671
C. Other (units not reported, or undisclosed) in thous. 1947 dollars	—	—	—	—	—	—	27,706	118,616	37,748	81,932
II. A. Total value, U. S. 1947 prices, (in thousands of dollars)	6,125	104,461	163,935	196,680	349,224	392,502	196,086	297,445	32[illegible]56	403,774
B. Index, U. S. 1947 = 100	1.9	32.4	50.9	61.0	108.3	121.8	60.8	92.3	[illegible]0.0	125.3

n.a. = not available or incomplete.
† Soviet 1956 production allocated on basis of 1955 distribution.
* Includes estimation of less than 2 percent of total.
** Includes estimation of less than 10 percent of total.

Note: Estimated classification of Soviet machine tools in U. S. equivalents and 1947 average unit prices are: 1. *Tokarnyye*—Bench and engine lathes, to 36" swing; gap lathes; other manufacturing and tool room lathes; speed lathes ($1,300). 2. *Revolvernyye*—Turret lathes ($5,886). 3. *Avtomaty tokarnyye*—Automatic chucking lathes and automatic between-center lathes ($12,372). 4. *Frezernyye*—Bench, hand, knee, and bed-type milling machines, single spindle ($3,453). 5. *Zuboobratyvayushchiya*—Gear cutting and finishing machines ($10,534). 6. *Rastochnyye*—Boring machines, excluding precision and jig ($23,652). 7. *Prodol'no-strogal'nyye*—Planers ($26,434). 8. *Poperechno-strogal'nyye*—Shapers ($3,850). 9. *Dolbezhnyye*—Slotters ($12,226). 10. *Protyazhnyye*—Broaching machines ($9,316). 11. *Shlifoval'nyye i Zatochnyye*—Grinding machines, excluding thread grinding ($487). 12. *Vertikal'no-sverlil'nyye*—Vertical drilling machines, excluding gang drills; sensitive drilling machines ($482). 13. *Radial'no-sverlil'nyye*—Radial drilling machines, plain type ($2,875). 14. *Prochiye: tochil'no-poliroval'nyye, boltoreznyye, gaykonareznyye i drugiye*—Honing, lapping and polishing machines; thread milling machines; threading machines ($538). 15. *Pilonasekal'nyye*—Sawing and cut-off machines; contour sawing and filing machines ($478). 16. *Spetsial'nyye, spetsializirovanyye i agregatnyye*—Precision and jig boring machines; gang drills; multiple-spindle and deep-hole drilling machines; lathes, over 36" swing; automatic screw (bar) machines; axle and other special lathes; bed-type, double spindle and special purpose milling machines; planer-type milling machines; profiling machines, duplicators, and die-sinking machines; other special milling machines (except thread milling machines); centering machines; and keyseating machines ($8,819).

Methodology: Soviet production was multiplied by the corresponding unit price to obtain total value in 1947 dollars. U.S. data were allocated and combined into the classification above. The residual values, in 1927, 1939, and 1956, of nonreported, combined or undisclosed production were adjusted to 1947 values. The adjustments were made by applying to the nonreported production the price indices of current to 1947 dollar values calculated for the identical reported production or shipments.

The result obtained, i.e. approximately equal U.S. and Soviet 1956 production, in value terms, is also indicated by the relative quantities of metal consumed or tonnage produced. The Soviet production, in 1956, was expected to be 250,000 metric tons, while the U.S. consumed, in 1954, 286,000 metric tons of metal. (The total value of shipments in 1954 was almost identical to that in 1956: 879 and 880 million [current] dollars, respectively.)

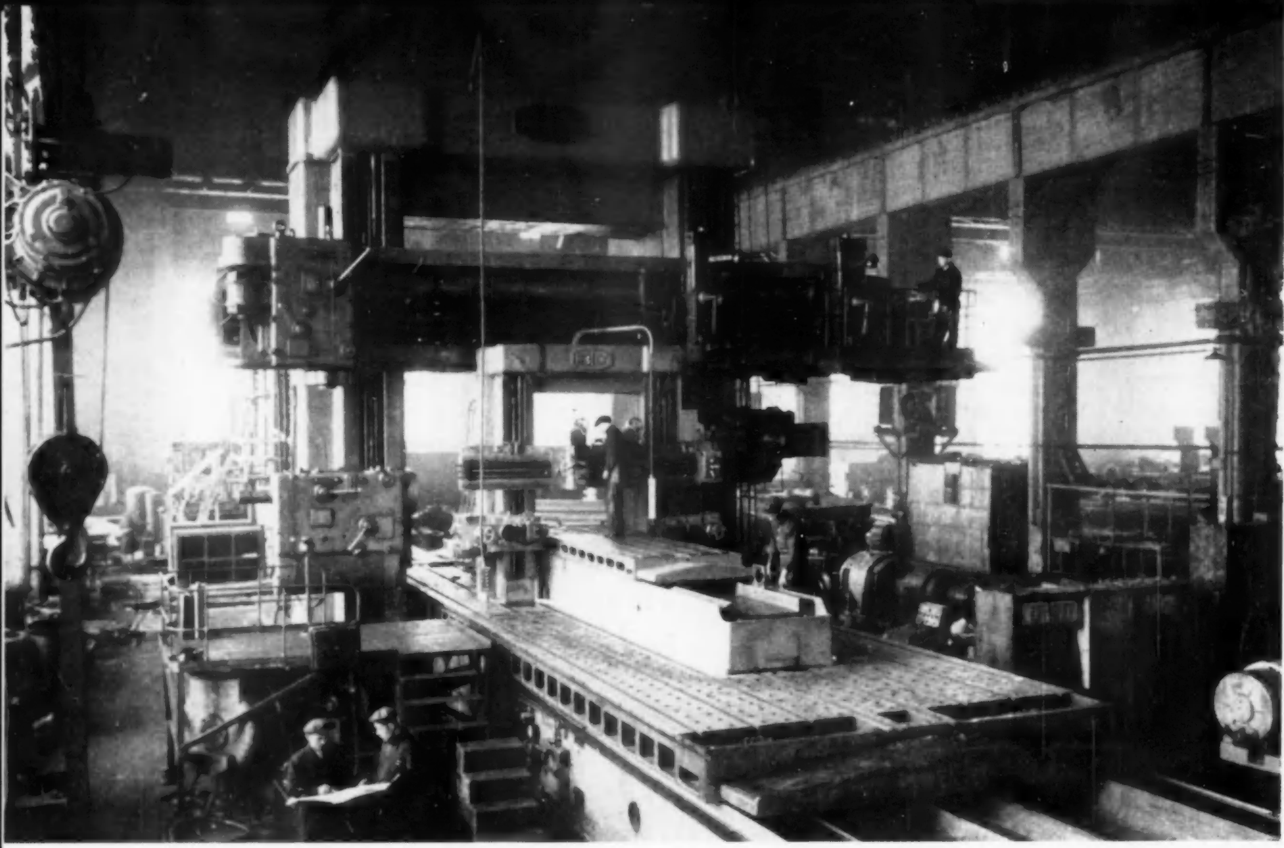
Sources: TsSU: *Promyshlennost' SSSR. Statisticheskiy sbornik (Industry of the U.S.S.R. A Statistical Handbook)*, Moscow, 1957, pp. 208-209, 428; Detailed machine tool specifications are found in N. M. Kaplan and W. L. White, *A Comparison of 1950 Wholesale Prices in Soviet and American Industry*, Rand RM-1443, 1 May 1955, Santa Monica, Calif., 1955, pp. 194-210; U.S. Department of Commerce. Bureau of the Census: *Biennial Census of Manufactures: 1927*, Washington, D. C., 1930, pp. 1094-1095; *ibid: Census of Manufactures: 1947, vol. II, Statistics by Industry*, Washington, D. C., 1949, pp. 660-662; *ibid: 1954 Census of Manufactures:*, "Metalworking Machinery," Bulletin MC-35B, Washington, D. C., 1957, p. 19; *ibid: Facts for Industry*, "Machine Tools, 1956," Series: M35E-06, Washington, D. C., September 20, 1957, pp. 4-7; and "Report on Russia," Part 2, "Russia's Sixth Five-Year Plan," *American Machinist*, December 3, 1956, p. 139.

COMPARATIVE TRENDS IN SOVIET AND U. S. MACHINE-TOOL PRODUCTION SELECTED YEARS, 1927-1956

total industrial costs, compared to 50.8 per cent in 1934, itself a poor agricultural year. The share of raw materials costs in the manufacture of cotton cloth rose, over those years, from 63.7 to 85.6 per cent; that in sugar refining, from 73.1 to 79.2 per cent; that in meat processing, from 80.0 to 93.5 per cent.

Within the Soviet industry, labor productivity has developed inadequately. In 1956, the productivity of the Soviet industrial labor force (including the industrial work of collective farmers) was, at most, a third as high as the American, on a man-year basis, and about 28 per cent as high, on a man-hour basis. By branch, Soviet industrial productivity ranges from about 50 per cent of the American level in electronics and strip coal-mining, to about 10 per cent in logging and quarrying. The growth of labor productivity in the Soviet Union has been comparatively slow. In 1956, Soviet man-year productivity was 126 per cent higher than in 1928; man-hour productivity had not quite doubled. Since 1951, Soviet man-year productivity has been increasing at some 5 per cent per year—a rate comparable to that of Western Europe.

The use of capital in Soviet industry has also been less intensive than in the United States, particularly as measured by output per unit of floor space. In terms of annual output per horsepower installed, the utilization of producers' durables by industry is much more creditable. In a



Russia's largest machine tool takes work up to 40 ft long and 13 ft square, and weighing 100 tons. The giant planer dwarfs the smaller machine of similar type shown here on its sliding table. Twenty-two flat cars were needed to ship the large planer from the factory.

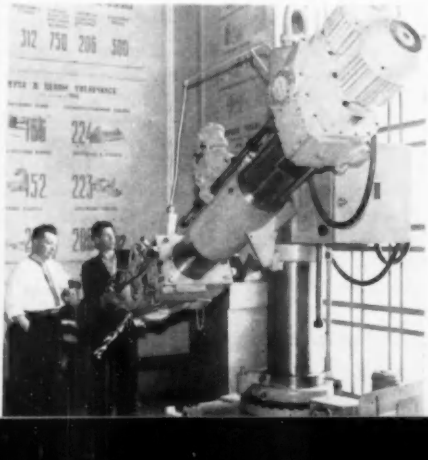
Soviet Plant Equipment

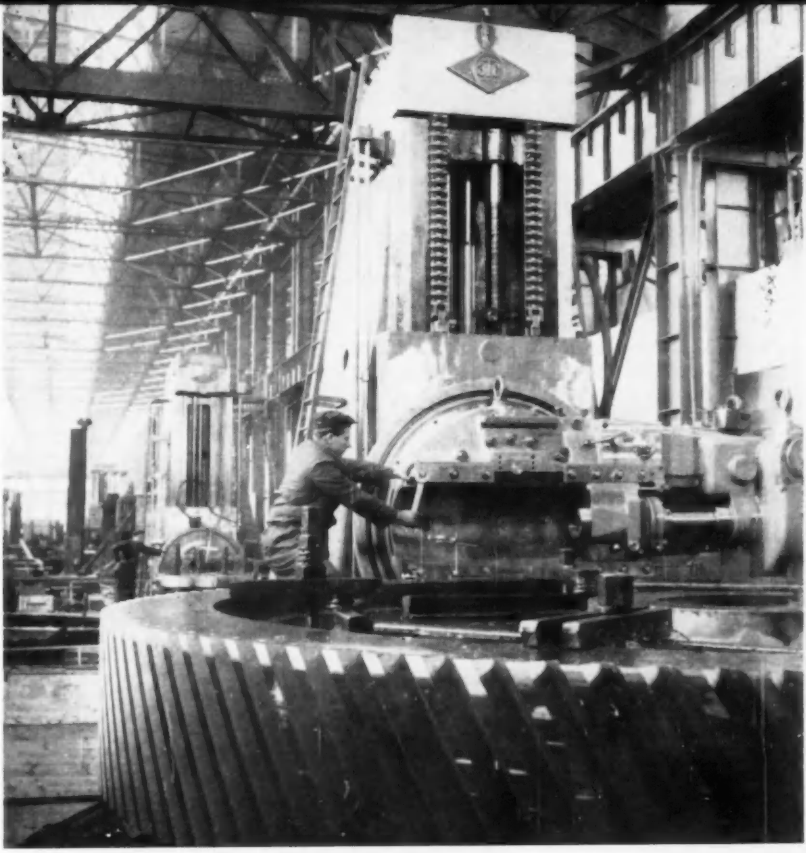
PRESENTED on these two pages are some selected examples of large machines used in Russian factories

Assembly of a six-spindle vertical chucker at the Krasnyy Proletary plant.

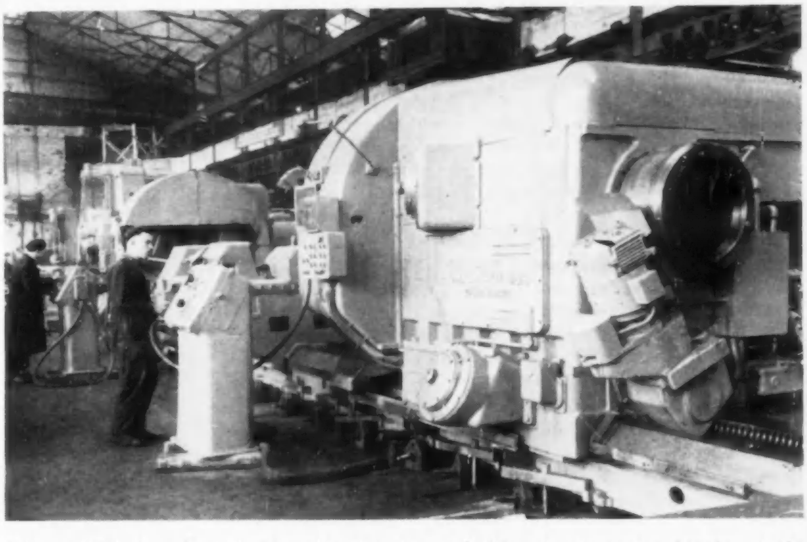
Centerless grinder at the automatic bearing plant in Moscow

Radial drill with swivelling and tilting head, made in Odessa, is similar to a Czechoslovak design.





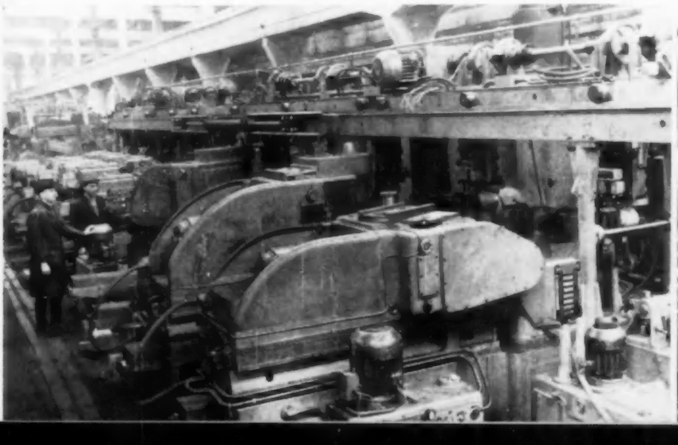
Heavy gear millers made at the Kolomna machine tool factory cut gears up to 10 ft diameter

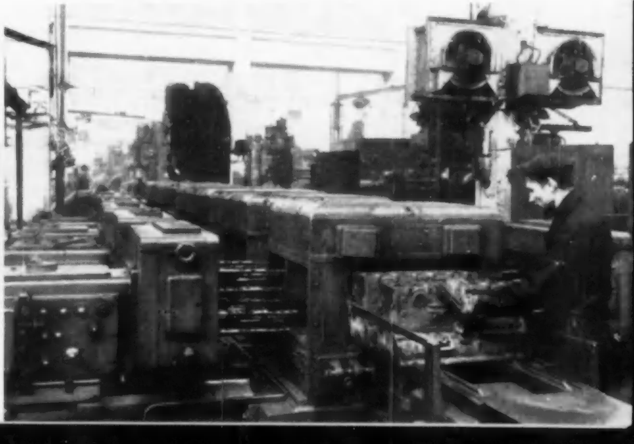


Large horizontal boring mill made at the Sverdlov Machinery Factory in Leningrad.

Below shows assembly of a six-station automatic transfer line at the Ordzhonikidze Machine Tool Factory in Moscow. It is intended for machining parts for agricultural equipment.

Below, right, is automatic transfer line for machining truck engine blocks at the Molotov plant in Gorkiy.





few branches, such as strip coal-mining, it is outstanding. The physical output of Soviet strip mines was 64.9 million m.t. in 1955, some 58 per cent of the comparable American figure in weight but substantially less in heat content. But Soviet equipment included only 764 power shovels and 101 draglines, compared to 3705 power shovels and draglines in American strip mines. Soviet employment totalled 30,417 workmen and perhaps 5000 others, compared to 29,871 persons in the United States. The basic reason for Soviet success lies in concentration, for the USSR operates only 42 strip mines, whereas there are 1516 bituminous strip mines alone in the United States.

Such exceptional performances are counterbalanced by poor work in other industries. Perhaps the worst instance is the logging industry, in which the power installed is almost six times as high as in American logging, but where output is comparable and labor productivity is only a tenth as high. Underground coal mining manifests perhaps average efficiency. Conditions are not dissimilar in the two countries, with the favorable and unfavorable features in seam thickness, pitch and depth, and in scale of operation, approximately in balance. But the power installed in Soviet underground coal mines is a fifth higher than in their American counterparts. Also, Soviet mining equipment is advanced: in 1955, the Soviets operated 2145 continuous coal cutters; the United States, about 500. Yet the product of Soviet underground mines was slightly less in tons (326.4 million m.t. against 330.9 million in the United States) and substantially less in heat value. As J. D. Morrow has shown, the basic deficiency in Soviet coal mining has been the continued use of the unproductive but initially cheaper long-wall system rather than the pillar-and-chamber design customary in American and Polish mines. Soviet employment in underground mining included 860,000 wage workers, nearly 100,000 employees and technicians, over 35,000 others in coal-washing plants and almost 60,000 in electro-mechanical and repair shops. Comparable American employment totalled 229,000.

Other expressions of high cost in Soviet industry are found in the prevalence of waste, e.g. in flaring natural and manufactured gas, and in metal-working operations; ponderous design, especially in machinery; low product quality, as in petroleum refining and peat milling; and the extensive industrial pollution of air and water. Labor safety has been relatively neglected until recently.

Soviet industrial equipment is not being amortized at significant rates. Machine-tool replacement since 1950 has not exceeded two to three per cent per year. In copper mining, the planned amortization period for fixed capital is 86 years. Soviet equipment in the textile industries is particularly antiquated.

Finally, the extreme emphasis put upon maximum output, the rigid bureaucratic lines of authority, the insufficient economic training of management, and the distortion of price relationships by subsidies and surcharges have combined with an aging industrial plant to produce structural rigidity. Such rigidity is perhaps most evident in the composition of fuel output. The proportion of Soviet energy derived from liquid and gaseous fuels has risen from only 20.3 per cent in 1940 to 22.9 per cent in 1955, although Soviet authorities themselves have stressed that, in 1955, the productivity of labor (per unit of heat output) was 4.4 times as high in petroleum extraction as in coal mining, and 11.7 times as high in petroleum extraction as in peat mining. In the United States, the proportion of energy production derived from liquid and gaseous fuels has risen from 43.6 per cent in 1940 to 66.7 per cent in 1955. The transition to high-caloric, easily transportable fuels has profound implications for the entire economy. Large savings in capital and labor are realized in production, transportation, and distribution; by-product industries are created; and the mechanical efficiency of the consuming equipment is far higher—25 to 35 per cent compared to 3 to 6 per cent for low-pressure steam equipment.

c. Structural Characteristics

Soviet efforts to achieve economies of scale through the concentration of production, on one hand, and limitations to change imposed by scarcity of capital and by a non-competitive system, on the other, have created a co-existence of giant plants and tiny shops in Soviet industry. In 1955, 690,000 industrial establishments, twice as many as in the United States, were operating in the Soviet Union. But 40 per cent of all Soviet employment was concentrated in about 500 establishments, with more than 3000 employees each. Not more than 15 per cent of American industrial employment was in establishments of this size. The largest Soviet plants reflect not only substantial scales of basic production, but the agglomeration of a vast variety of subsidiary and by-product output in one establishment. The virtual industrial manors so created originated from unreliabilities of transportation and the desire for the self-sufficiency of key plants, prior to World War II. Shortages of managerial skill, inadequate inter-plant standardization and communication, the desire to utilize industrial wastes and idle capacity, and the desire to provide consumers' goods as employee incentives have perpetuated this type of organization.

The duality of the Soviet industrial structure is reflected in extraordinary inter-plant variations in productivity. For example, labor productivity in the smallest Soviet cement plants (those producing less than 100,000 m.t. per year) was under 40 per cent of the cement industry average in 1955; that in the largest plants ran 35-45 per cent higher than the average. In Kharkov, in 1956, the output per wage worker in the smallest foundries, with only 10-15 employees each, was only 6 to 7 metric tons per year, compared to an average of 35 to 40 metric tons for all foundries in the city, and peak performances of 50 to 60 metric tons per year in the most efficient plants.

Clearly, the product-mix, the organization, and the motivations of Soviet industry have produced a system of operation far different from that of the United States. Comparisons can be made between the two, but only with care.

III Prospects for Further Industrial Growth

SOVIET achievements in military production and industrialization, as a whole, have been substantial. Nevertheless, the Soviet bloc is still far from possessing a preponderance of world military-economic capacity. Soviet industrial output today is 35 to 40 per cent as great as that of the United States. Since the end of World War II, the output of Soviet industry has expanded at a faster *rate* than the American, but no faster, since 1951, than in Western Europe. This fact, the great *absolute* scale of American industrial expansion and recently lagging production in the European Soviet satellites, have limited Soviet-bloc gains in relative output. The steel output of

TABLE IV

Age and Industry Group	U. S. S. R. 1926	1937	1940	1950	1955	1956	1965	United States 1930	1940	1950	1956	1965
Total population aged 15 and over[1]	92.3	105.9	126.6	125.6	140.9	143.6	160.6	89.0	101.1	112.4	120.1	137.2
1. Males aged 15-59	39.1	45.0	54.2	50.9	58.0	59.2	65.3	39.8	43.7	46.5	49.0	55.5
2. Females aged 15-54	41.0	47.4	56.3	58.8	63.6	64.3	66.1	36.6	40.8	43.9	45.9	51.7
Subtotal	80.1	92.4	110.5	109.7	121.6	123.5	131.4	76.4	84.5	90.4	94.9	107.2
3. Over-aged[2]	12.2	13.5	16.1	15.9	19.3	20.1	29.2	12.6	16.6	22.0	25.2	30.0
I. Civilian employment (excluding domestics and casually employed)[3]	69.9	75.4	84.4	85.2	92.0	95.4	n.a.	43.4	41.7[4]	51.7[4]	56.1	n.a.
1. Non agricultural	10.1	31.1	37.4	44.1	49.3	50.9	n.a.	33.2	33.3	45.1	50.0	n.a.
(a) Industry[5]	4.9	13.7	16.7	18.8	22.0	22.7	n.a.	13.0	12.5	16.6	18.9	n.a.
(b) Construction	0.3	3.2	3.5	4.4	5.0	5.2	n.a.		2.0	3.0	2.5	n.a.
(c) Transportation and communication	1.3	3.3	4.0	4.5	5.5	5.7	n.a.	3.5	2.3	3.1	3.0	n.a.
(d) Services	3.6	10.9	13.2	16.4	16.8	17.3	n.a.	16.7	16.5	22.4	25.6	n.a.
2. Agricultural (including forestry)	59.8	44.3	47.0	41.1	42.7	44.5	n.a.	10.2	8.4	6.6	6.1	n.a.
(a) Able-bodied[6]	53.6	38.7	40.9	35.5	36.6	37.8	n.a.	8.8	7.1	5.5	5.1	n.a.
(b) Over-aged[2]	6.2	5.6	6.1	5.6	6.1	6.7	n.a.	1.4	1.3	1.1	1.0	n.a.
II. Armed Forces, Communist party officials, and other related[7]	0.7	2.0	5.5	5.0	6.0	4.5	n.a.	0.3	0.4	1.5	2.9	n.a.
III. School enrollment (excluding correspondence)[8]	0.5	2.4	3.4	3.1	7.9	8.2	n.a.	9.3	9.9	10.8	11.8	n.a.
Of which, not employed[9]	0.5	2.4	3.4	3.0	7.7	7.9	n.a.	8.4	9.4	9.1	9.6	n.a.
IV. Casually employed (domestics, day laborers, etc.), unemployed, housewives, retired, and others	21.2	26.1	33.3	32.4	35.2	35.8	n.a.	36.9	49.6	50.1	51.5	n.a.

[1] U. S. data include population aged 14 and over; census figures are as of April 1; 1956 and 1965 data are for the midyear. U.S.S.R figures are for midyear, except for 1926 census figures (December 17).

[2] Males aged 60 and over; females aged 55 and over.

[3] U. S. data exclude persons working less than 15 hours per week; Soviet data are man-year equivalents.

[4] Excludes employed persons undistributed by industries.

[5] "Industry" is defined here, according to the Soviet concept, to include manufacturing, fishing, electric utilities, and transport repair workers. U. S. data have been adjusted to this concept.

[6] U.S.S.R.: males, 15-59, females 15-54; U. S.: males 14-59, females 14-54. Soviet data understate the number of people employed because of conversion to man-year basis.

[7] U. S. data include Armed Forces only.

[8] U. S. data include persons 14 and over enrolled in school; Soviet data include students enrolled in grades 8-10, technicums, and higher educational institutions.

[9] U. S. data reported; Soviet figures are estimates made by computing the number of students enrolled in night school at the technicums and higher educational institutions.

Sources: U.S.S.R.: The primary sources for population data are Ts.S.U., *Vsesoyuznaya perepis' naseleniya 1926 goda (All-Union Census of Population, 1926)*, vol. 17, Moscow, 1929, pp. 46-48, and A. A. Campbell and J. W. Brackett, *Estimates and Projections of the Population of the U.S.S.R.*: 1950-1976, U. S. Department of Commerce, Bureau of the Census, 1958, Tables 1 and 2, pp. 2, 3. Employment data are provisional figures from a study of the Soviet labor force which is being prepared in the Foreign Manpower Research Office. Figures are annual averages, except for 1926 census data.

U. S.: Both population and employment data are from 1930, 1940, and 1950 census volumes and U. S. Department of Commerce, Bureau of the Census, *Statistical Abstract of the United States, 1957*, Washington, 1957, passim.

MANPOWER UTILIZATION IN THE U.S.S.R. AND THE UNITED STATES: SELECTED YEARS, 1926-1965
(In millions)

the Soviet Union and its European satellites, which had been about 20 per cent that of the NATO countries in 1948, rose to about 31 per cent by 1952, and to about 33 per cent in 1956. The bloc's cement output has continued to make gains vis-a-vis the West: for example, 14 per cent of NATO output in 1948, 24 per cent in 1952, and 30 per cent in 1956. Its fuel supply, too, has expanded somewhat more rapidly than that of the West: about 21 per cent of the NATO level in 1948, 26 per cent in 1952, and 31 per cent in 1956. And a fifth of Western fuel supplies, it must be cautioned, comes from Asia and Latin America, some areas of which are politically vulnerable.

One course open to the Soviet Union in pursuit of its goal is an attempt to wipe out Western margins of economic superiority through continued, intensive industrialization. This course involves both difficulties and new potentials.

The basic difficulties are twofold. One is manpower. Between 1950 and 1956, the Soviet Union enjoyed a growth of 13.8 million in its population of prime working ages, i.e., males aged 15-59 and females aged 15-54 years. This increase was three times as great as the corresponding gain in the United States (Table IV). But between 1956 and 1965, the anticipated growth in size of this age group is only 7.9 million persons in the USSR compared to a gain of 12.3 million for the United States. Furthermore, the Soviet Union is already utilizing its manpower extensively, with 70 per cent of the adult population regularly employed, on a 46-hour basic work week. The United States, in which only half the adults are employed for more than 14 hours a week, and in which there is an average work week of 40 hours, can intensify manpower utilization much more readily. Finally, the rapid growth of Soviet population since 1950 is making the demands for increased agricultural production and for an expansion of general educational facilities increasingly pressing.

Soviet capital resources must satisfy an enormous pent-up demand generated by the inadequate capacity and obsolescence of the nation's industrial plant, transportation system, and housing. In addition, basic weaknesses in the country's capacity for passive defense—a paucity of signal communications, a high physical concentration of prime industrial capacity, a high density of urban settlement, weak local transportation nets, and shortages of reserve stocks of every variety—threaten the Soviet Union's strategic security. To rectify these weaknesses

(*Turn to page 122, please*)

The Soviet Automotive Industry

. . . A CURRENT ASSESSMENT . . .

By Barney K. Schwalberg

FOREIGN MANPOWER RESEARCH OFFICE
U. S. Department of Commerce
BUREAU OF THE CENSUS

I
Introduction

THE Soviet automotive industry is in many ways similar and as often dissimilar to its American counterpart. Comparisons between the two nations with respect to the structure and operations of automotive manufacturing as a major industry have much intrinsic merit, but there is also a wider significance to be discerned. In the USSR the automotive industry has evolved to its present status under the impact of unique political, economic, and technological tendencies and practices affecting Soviet heavy industry in general and the machine building industries in particular. The characteristics of the automotive industry today and the factors which have contributed to its development are of much interest in their own right, but the light they shed on the broader problem of Soviet industrial development tends even more to commend them to the attention of Western observers of Soviet affairs.

A brief survey of the industry will be helpful in developing a proper perspective.

The total output of motor vehicles in the USSR in 1957 came to about 500,000 units. Of this total, roughly three-quarters were trucks. Production is concentrated in the Gorkiy and Moscow metropolitan areas, which account for about 75 per cent of national output. Smaller plants in 9 or 10 other cities, several assembly plants, and several dozen component and spare-parts producers comprise the remainder of the industry. Total employment in 1955 is estimated to have been about 200,000, including 165,000 wage workers. In general, Soviet automobile plants are relatively large, unspecialized, independent establishments.

Although long hailed as the technologically most advanced branch of Soviet machine building, the automobile industry has been losing ground steadily. This decline has been characterized by increasingly obsolescent technology, inefficient organization of labor, and inferior prod-

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  2. The ZIL Group — ZIL, ZIL-Allied Plants: MMZ, KAZ, DAZ, LAZ, Ural ZIS
  3. The Smaller "Independents"— MAZ, YaAZ, MZMA
- C Subsidiary Producer Plants

III Production and Product Makeup
- A Trends and Comparisons with the U. S.
- B Product Makeup: 1. Trucks 2. Passenger Cars 3. Buses

IV The Basic Problem: Lagging Technology
- A Introduction
- B General Evaluation of Soviet Motor Vehicles
- C Production Technology: Metal Working, Assembly, Automation
- D Organization of Labor

V The Outlook for the Soviet Automotive Industry

PRODUCTION OF MOTOR VEHICLES IN THE USSR, SELECTED YEARS, 1932-1957

	Thousands of Units Produced				Production Index, 1950 = 100			Percentage Distribution of Output by Type		
		Including				Including			Including	
Year	Total	Trucks	Cars (including jeeps)	Buses	Total	Trucks	Cars (including jeeps)	Total	Trucks	Cars (including jeeps)
1932	23.9	23.8	.03	[1]	7	8	—	100.0	99.2	0.8
1937	199.9	180.3	18.2	1.4	55	61	28	100.0	90.2	9.1
1940	145.4	136.0	5.5	3.9	40	46	9	100.0	93.5	3.8
1945	74.7	68.5	5.0	1.2	21	23	8	100.0	91.7	6.7
1946	102.2	94.6	6.3	1.3	28	32	10	100.0	92.6	6.2
1947	133.0	121.2	9.6	2.2	37	41	15	100.0	91.1	7.2
1948	197.1	173.9	20.2	3.0	54	59	31	100.0	88.2	10.2
1949	276.0	226.9	45.7	3.4	76	77	71	100.0	82.2	16.6
1950	362.9	294.4	64.6	3.9	100	100	100	100.0	81.1	17.8
1951	288.7	229.8	53.6	5.3	80	78	83	100.0	79.6	18.6
1952	307.9	243.5	59.7	4.7	85	83	92	100.0	79.1	19.4
1953	354.2	270.7	77.4	6.1	98	92	120	100.0	76.4	21.9
1954	403.9	300.9	94.7	8.3	111	102	147	100.0	74.5	23.4
1955	445.3	329.0	107.8	8.5	123	112	167	100.0	73.9	24.2
1956	464.6	357.6	97.8	9.2	128	121	151	100.0	77.0	21.0
1957(1st half)	244.0	184.0	55.0	5.0	—	—	—	100.0	75.4	22.5

[1] A small number of chassis for buses and fire engines is included in the truck figure.
Sources—1932-1955: *Tsentral'noye statisticheskoye upravleniye pri sovete ministrov SSSR, Promyshlennost' SSR — statisticheskiy sbornik* "The Industry of the USSR — A Statistical Handbook", Moscow, 1957, p. 223.
1956: *Narodnoye khozyaystvo SSSR v 1956 godu — statisticheskiy yezhegodnik* "The National Economy of the USSR in 1956 — A Statistical Annual", Moscow, 1957, p. 62.
1957 (1st half): *Trud*, 20 July 1957.

TABLE I

ucts. The origins of this trend are believed to lie in a bureaucratic, mechanically quantitative approach to production, in which all available energy has been devoted to the fulfillment of periodic output goals. Quality and cost have been virtually ignored. Shortages of materials, funds and qualified personnel are believed to have been contributing factors. Whether this deterioration will continue, or be arrested, or even reversed in the future depends upon several factors. The most important of these, and one that indicates the probability of future improvement, is the industry's newly discovered post-Stalin ability to recognize many of its own shortcomings.

II
The Soviet Automobile Plants
Functions, Location, Product Makeup

A Functions

In contrast with most American automobile factories, the major Soviet plants are highly self-contained units, each making a very large proportion of its own tools, equipment, and parts. Manufacture runs from the pouring of iron in the foundry to the assembly of finished vehicles. It includes such activities as the production of instruments and standard hand and machine tools, as well as of forging and stamping dies and casting molds. Some factories operate their own foundry sand-pits and electric power plants. They repair their own equipment and manufacture the necessary spare parts for it. Packing equipment and containers are also produced in automobile plants. In general, the necessity for these auxiliary production activities arises from the under-developed state of specialized industries in these fields.

Apart from production facilities, automotive plants have departments engaged in providing for their workers such facilities and services as day nurseries, restaurants, "palaces of culture," training schools, housing, the publication of plant newspapers, etc. Also the plants produce a large assortment of non-automotive consumers' goods.

FIG.1—MOTOR VEHICLE PRODUCING CENTERS OF THE USSR

Generally, the larger and older the plant is the more diverse are its production and service activities.

B Location and Product Line

Soviet automobile production is concentrated in the central industrial region of European Russia (Fig. 1). This area, which accounted for virtually all the USSR's prewar vehicle output, still produced nearly 80 per cent

of the total in 1956. Two large establishments: the Gorkiy Automobile Plant (GAZ) and the Moscow Automobile Plant named after Likhachev (ZIL) manufactured roughly two-thirds of all Soviet vehicles in 1956 (Table II). The 12 other vehicle plants are all much smaller than either of these two. Nine are of wartime or postwar vintage. Operationally, eight are allied to one or the other of the big two. They turn out GAZ and ZIL models, and rely upon one or even both of the parent plants for technical assistance and an often considerable variety of parts and components. Of the four remaining plants, three produce basically their own vehicles, while the last is a relatively new plant in the Siberian city of Novosibirsk about which little is known.

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1 THE GAZ GROUP

(a)—GAZ (an abbreviation for the Russian phrase meaning "Gorkiy automobile factory") is the largest automobile plant in the USSR. It may also be the largest manufacturing establishment of any kind in the nation. Its output, roughly half of the Soviet total for the industry, consists primarily of 2.7-ton capacity GAZ-51 trucks and Volga passenger cars. More than a million of the former, Russia's most common motor vehicle by far, have been produced since 1946. The Volga replaced the Pobeda in production in 1956.

Two modifications of the GAZ-51 are produced: a 4x4 cross-country model (GAZ-63) and a rear dumper (GAZ-93). The plant's products also include relatively small numbers of a heavier passenger car (ZIM) and new 1.65-ton capacity trucks (GAZ-56). About a third of GAZ's output (in value terms) consists of non-automotive production. This includes bicycles; machine tools; forging, stamping, smelting, and welding equipment; small electrical devices; radios; and "tens of thousands of oil cans every month." The technological level of the machine shops at GAZ is outstanding in Soviet practice.

The number of workers employed at the plant was recently reported to be 45,000. This would place its total labor force at about 60,000, including engineering and administrative overhead. However, there is considerable evidence that the former figure, which comes from a Soviet source, is a significant under-statement and that a figure about 50 per cent greater may be more accurate.

(b)—The GAZ allied plants are:

i. The nearby Pavlovo Bus Plant (PAZ) which turns out buses on the GAZ-51 chassis (PAZ-651).

ii. The Ulyanovsk Automobile Plant (UAZ) which produces GAZ-69A jeeps, a line of production recently transferred from GAZ to this plant. Its first jeeps, in 1955, consisted almost entirely of GAZ-supplied parts; by mid-1957, 75 per cent of the vehicle's components were being produced at UAZ. By that date, 40,000 jeeps had been turned out by this factory. UAZ is now preparing for production of the UAZ-450, a small, 1300-lb capacity truck built on the jeep's engine and chassis.

iii. The Odessa Automobile Assembly Plant, which turns out GAZ-93 dump trucks. The assembly plant apparently receives almost all components except the body. Some come from UAZ as well as GAZ. The body model produced is an enlarged form designed for transporting grain, vegetables, fertilizer, and other agricultural materials.

2 THE ZIL GROUP

(a)—ZIL (an abbreviation for the Russian phrase meaning "factory named for Likhachev") is a relatively new name in the industry. For about 25 years this plant was named ZIS (an abbreviation for the Russian phrase meaning "factory named for Stalin"). It was renamed in honor of its long-time late director, Ivan Alekseevich Likhachev, in 1956. ZIL's automotive output consists primarily of the 4.4-ton capacity ZIL-150 truck and modifications thereof. These include the cross-country 6x6 model (ZIL-151) and a city bus (ZIL-155). All three of these models are currently being modernized, the new versions bearing the designations ZIL-164, ZIL-157, and ZIL-158 respectively. This plant also produces the ZIL-127 intercity bus. In addition a very small number of new deluxe ZIL-111 limousines is being produced. Like GAZ, ZIL is also burdened with a large amount of unspecialized, non-automotive production. Its products include electric refrigerators and large presses for the Polish and Chinese automobile industries. ZIL was semi-officially reported to have 40,000 workers on its payroll in 1954.

(b)—ZIL-allied plants comprise:

i. The Mytishchiy Machine Building Plant (MMZ), located in the northern outskirts of Moscow, turns out ZIL-585 dumpers. These vehicles use the ZIL-150 engine and chassis, presumably received from ZIL. MMZ's function apparently consists of manufacturing and installing the body and hydraulic lift. This plant also produces subway cars, a seven-ton capacity trailer (MMZ-584), and a tractor to pull it (also using a ZIL-150 chassis).

ii. The Kutaisi Automobile Plant (KAZ), in the trans-Caucasian Georgian Republic, produces the KAZ-585 rear dumper. This truck is virtually identical to the ZIL-585. Reports of a KAZ-600, which tips to either side, and the KAZ-602, which dumps in three directions, have also been received. In addition, this plant also produces tractor-trailers. All of its vehicles are intended primarily for transporting cotton.

KAZ is distinguished by its status as the problem child of the industry. It often fails to meet its production goals, labor productivity is low, manufacturing costs are high, absenteeism is a problem, and its directors have been accused of bureaucratic mis-management. It is another complete-cycle plant, but has encountered serious problems in the primary stages of the production cycle.

A check of the records of the gray iron casting shop, included in a 1955 survey of the plant, showed a reject rate approaching 28 per cent. Further investigation revealed that the true rate was a great deal higher and that this was being concealed by avoidance of quality control inspection in certain instances. In addition, short-

ages of castings frequently necessitate the procurement of such components as rear axle housings from other automobile plants. Sometimes they have to be delivered by air to avoid protracted production delays. Such flights, needless to mention, are quite costly. Another of the plant's primary shops, Foundry Shop No. 2, was recently reported to be the source of 70 per cent of the plant's gross losses.

In defense of KAZ, the Secretary of the Central Committee of the Communist Party of Georgia, recently pointed out that although construction was begun 12 years ago, certain primary metal processing shops have not yet been completed. This has resulted in only partial utilization of the capacity of other shops and a costly dependence upon ZIL, more than 1200 miles away.

That such plant difficulties have been reflected in the quality of the vehicles produced is indicated by the following press report from an Andizhan (Uzbek SSR) motor pool:

> "In July (1957) we received 20 KAZ-585B dumpers . . . and none were in working order. They started to fall apart as early as their movement from the railroad station to the motor pool. The inhabitants of Andizhan were witnesses to a curious picture suggesting the picking of berries or mushrooms. Our drivers walked along the road with boxes picking up the nuts, bolts, screws, and washers 'lost' by the dumpers. But that's only the half of it. We quickly fixed the minor defects. The saddest part started when the trucks had gone 500 to 1000 kilometers. Gear boxes, rear axles, propeller shafts or something else went out of order. Each time factory defects were the cause."

iii. The Dnepropetrovsk Automobile Plant (DAZ) produces ZIL-150 and ZIL-585 trucks under its own trademark. Although information on this plant is extremely scanty, it appears to account for a large proportion of total Ukrainian truck production.

iv. The Lvov Autobus Plant (LAZ) manufactures three-ton capacity autocranes mounted on ZIL-150 trucks, and "Lvov" city buses with the ZIL truck chassis and engine. Although bus output at LAZ is extremely limited at present (planned January, 1957 output was 30 vehicles), it appears likely that this plant will become one of the nation's major bus producers in the next few years. The detrimental effect upon ZIL's truck production of a nonspecialized production of ZIL-155 buses may contribute to a transfer of emphasis to the Lvov plant.

v. The Miass Automobile Plant (Ural ZIS) is located in the South Urals near the Chelyabinsk metallurgical center. It produces two modifications of the old ZIS-5, a 3.3-ton capacity truck of 1933 vintage. One is Ural ZIS-355, a modernized version which uses many ZIL-150 components. This truck is widely used in agricultural areas. The other is the Ural ZIS-352, a 2.7-ton capacity gas-producer truck which burns wood blocks. It is most widely used in the timber industry. This plant was built during World War II with equipment evacuated from ZIL (then ZIS). During the war it was the USSR's main domestic source of medium capacity trucks; the ZIS and GAZ plants having been largely converted to ordnance production. It is said to have "a complete production cycle" with apparently limited dependence upon other plants for parts.

3 THE SMALLER "INDEPENDENTS"

(a)—The Minsk Automobile Plant (MAZ) is the most important automotive plant built in the USSR since World War II. It specializes in Diesel trucks of medium and very heavy capacity. Its basic vehicle is the MAZ-200, a two-axle 7.7-ton capacity truck having a four-cylinder 110-hp Diesel engine. Several modifications of this vehicle are also produced: the MAZ-205, a 5.5-ton capacity dumper; the MAZ-501, a timber tractor; and the MAZ-502, a 4.4-ton capacity 4x4 cross country model. In addition, MAZ makes a 27.5-ton capacity dumper (MAZ-525) with a 12-cylinder 300 hp engine, and has produced experimental models of a three-axle, 45-ton capacity dumper (MAZ-530) equipped with a 12-cylinder four-stroke 450-hp engine. MAZ is one of the largest industrial establishments in Byelorussia and the largest producer of Diesel trucks in the USSR.

(b)—The Yaroslavl' Automobile Plant (YaAZ), the third of the major prewar plants, specializes in Diesel engines and large trucks. The basic engines are the YaAZ-204 (used on the MAZ-200 series), and the YaAZ-206A which has six cylinders and a horsepower rating of 165. The latter is installed on the plant's trucks, which comprise the YaAZ-210 (a three-axle, 13-ton capacity model) and several modifications thereof. A recent addition to the plant's product variety is a 7.7-ton capacity 6x6 truck (YaAZ-214) equipped with a 205 hp engine. The latter is a modification of the YaAZ-206A, called YaAZ-206B. Another modification, the 180 hp YaAZ-206D, is used on the ZIL-127 intercity bus. So far as can be determined, YaAZ is the sole large-scale producer of

TABLE II

Republic	Region	City	Identified Finished Vehicle Producing Plants Within Geographic Area	Production (thousands of vehicles)	Basic Product Makeup
USSR, total	—	—	—	464.6	
RSFSR	Central	—	—	368.0	trucks-buses-cars
		Moscow	—	140.0	trucks-buses-cars
			ZIL	(100.0)	trucks-buses
			MMZ		
			MZMA	(40.0)	cars
		Gorkiy	GAZ	220.0	trucks-buses-cars
			PAZ		
		Yaroslavl'	YaAz	(8.0)*	heavy Diesel trucks
	Ural	Miass	Ural ZIS	54.9	trucks-jeeps
	Volga	Ulyanovsk	UAZ		
Ukraine	—	Dnepropetrovsk	DAZ		
		Lvov	LAZ	21.5	trucks
		Odessa	Odessa Assembly		
Byelorussia	—	Minsk	MAZ	14.4	medium Diesel trucks
Georgian SSR	—	Kutaisi	KAZ	5.8	trucks

* There is a possibility of a large *relative* error in this estimate.

ESTIMATED DISTRIBUTION OF SOVIET MOTOR VEHICLE PRODUCTION BY CITY AND PLANT, 1956

(Figures in parentheses ( ) are estimates derived indirectly from fragmentary data)

automobile Diesel engines in the USSR. It has newly built, mass-production engine and assembly shops. Its truck production, on the other hand, is limited by the inadequacy of its basic metal-processing shops and by the failure to complete construction of various others. It has been suggested that the plant specialize solely in Diesel engines, which already represent half of its output, rather than make the investment necessary to overcome these difficulties. YaAZ works closely with the Minsk Automobile Plant, trading its engines for basic chassis components at more or less regular intervals.

(c)—The Moscow Small-Car Plant (MZMA) produces the 35-hp Moskvich 402 passenger car. More of the 402's predecessors, the 400 and 401, are privately owned than any other cars in the USSR. MZMA does not appear to have a complete production cycle; ZIL and GAZ supply it with intermediate (semi-fabricated) products.

C Subsidiary Producer Plants

Soviet automobile plants, although generally highly self-contained, do not manufacture all of the parts and components themselves. The cost of materials and parts purchased from subsidiary automotive producers and from plants in other industries represents about 50 per cent of the production cost of Soviet motor vehicles. Tires and glass, for example, are procured from plants of the chemical and building-materials industries respectively. Within the automotive industry, a high degree of specialized subsidiary production of electrical equipment (starters, generators, spark plugs, etc.), carburetors, pumps, and similar parts has been achieved. Most of these plants are joined in the automobile appliance trust (Glavavtopribor). Some plants of this type are affiliates of a major primary producer, such as ZIL's carburetor and parts plants. Bearings are supplied by a large number of plants which were until recently subordinate to the Ministry of the Automobile Industry. Other plants manufacture pistons, piston rings, valves, etc. The most publicized of these is the automated plant at Ulyanovsk which produces pistons for ZIL engines. A small but growing number of specialized spare-parts plants should also be mentioned.

III

Production and Product Makeup

A Trends and Comparisons with the U. S.

Table I summarizes USSR motor vehicle output in three key prewar years and since the end of World War II. Certain facts should be noted concerning these data. First, they are quoted directly from official Soviet publications. Second, there is indirect evidence that military vehicles are not included. Third, the figures quoted for 1947-1950 are about 18 per cent below the levels implied by a collation of data for that period gathered from several Soviet sources. This discrepancy cannot be explained at present. In other respects, so far as is known, the series of Table I, is consistent with the body of available information. These data are believed to be acceptable as the civilian motor vehicle output of the USSR and are so used throughout this report.

As shown by the series, total output has increased at impressive rates but the rate of increase is diminishing. During the period 1945-1950, there was an average annual growth of 37 per cent. This was followed by the Korean War period cutback, so that the 1950 level was not surpassed until 1954. Following the sharp drop in output in 1951, the rate of increase during the succeeding five years (1952-56) averaged 10 per cent per year, considerably below that of the Fourth Five-Year Plan period, 1946-1950.

Comparisons with the United States are revealing. In terms of total output the United States produced 23 times as many vehicles as the USSR in 1937, and 14 times as many in 1956. Between 1937 and 1956 the vehicle output of the USSR increased by 132 per cent, whereas in the United States the increase amounted to only 44 per cent. Thus, although the rate of growth of vehicle production in the USSR has been three times as great as in the United States, the USSR still lags by a considerable margin because it started from a much smaller base. In fact, the margin by which U. S. production exceeds Soviet production was much greater in 1956 than in 1937, in terms of the absolute number of vehicles manufactured. In 1937, U. S. production exceeded Soviet production by 4.6 million vehicles; by 1956 this excess had grown to about 6.5 million vehicles.

If the comparison be narrowed to commercial vehicles (trucks and buses), the picture is somewhat different. Here Soviet production has increased from 20 per cent of the U. S. level in 1937 to 33 per cent in 1956, and the numerical margin of the U. S. has increased by only 28,000.

Furthermore, the average Soviet truck produced in 1956 was considerably larger than its American counterpart. Within the commercial vehicle field there are sub-areas of even more distinct Soviet progress. Their Diesel truck output in 1956, for example, although not ascertainable exactly, was probably about three-quarters of the U. S. figure of 25,800. (This is largely attributable to the Soviet use of such engines on their 30,000-lb GVW truck series. Gasoline engines are usually used on similar sized trucks in the U. S.) Furthermore, the Soviets are actually outproducing us in the 2.5 to 5-ton capacity gasoline-engine truck field. These trucks were designed with the poor Soviet roads in mind, and form a vital part of the nation's transportation system. However, the Soviet Union's concentration upon this class of vehicle has resulted in extreme and costly shortages of both lighter and heavier vehicles.

Soviet bus production in 1956 was more than double that of the U. S., but much of this output is needed to meet an unsatisfied backlog of demand and the growing demands for vehicles on the part of new or expanding bus lines. The proportion of buses manufactured which remains available for replacement of outworn or obsolete buses is rather inadequate. In the United States, on the other hand, most bus production is for the replacement market. It will probably be a long time before this situation is reached in the Soviet Union.

As far as passenger cars are concerned, Soviet production (including jeeps) amounted to less than two per cent of the American production in 1956. The data available indicate that one-third of Russia's car output is sold to individuals, the remainder going to State-operated motor pools, factories, collective and State farms, etc. As indicated by the last three columns of Table I, passenger car production as a proportion of total motor-vehicle output has been increasing since the end of World War II. Heavy consumer demand, although perhaps a contributing factor, does not appear to be the major cause of this trend. The urgent need of State motor pools for vehicles smaller than a 2½ ton truck for taxi and delivery service appears to be a more likely explanation. Jeeps, usable on country roads and compatible with military requirements, are particularly useful in these ways.

B Product Makeup

The Soviet automotive industry produces a very narrow range of basic vehicles. This has the advantage of simplifying the production and servicing of vehicles, and reduces the variety of spare parts. Such economy, the Soviets have long claimed, was a direct result of socialist planning. The fact that it was more than offset by wasteful, unspecialized utilization was not discussed. In fact, the large variety of vehicles produced in the U.S. was condemned as an unjustifiable waste characteristic of capitalist competition. However, the post-Stalin period has brought some adjustment in this attitude. The folly of viewing "the poor, limited variety of our motor vehicles as a positive, inherent characteristic of a socialist economy" is now openly acknowledged.

1. TRUCKS

(a)—Basic Models

In recent years, Soviet truck production has been limited to five basic series. The four most numerous are manufactured in dumper, cross-country (all axles driving) and tractor models, in addition to the predominant standard model. Over 90 per cent of the annual production is represented by the GAZ-51 and ZIL-150 series, trucks of 2.5 to 4.5 ton capacity, powered by gasoline engines (Table III). The ZIL-150 is being replaced by a modernized truck, the ZIL-164. Heavier Diesel-engine trucks, intended primarily for use in construction, mining and quarrying, make up the remainder of Soviet truck production. About 20,000 such vehicles, primarily standard and dumper versions of the MAZ-200 and the YaAZ-210, were produced in 1955.

Since the termination of GAZ-AA (modeled after the Ford AA) production about 1949, the Soviet Union has made no trucks of less than 2.2 tons capacity. This, and other changes in product-mix, have led to a steady increase in the average capacity of the trucks produced, from 2.4 tons per truck in 1940, to 3.3 tons per truck in 1950, to approximately 3.6 tons per truck in 1955. This has also resulted in a particularly troublesome and costly gap in the Soviet truck range. Steps are currently being taken to remedy that deficiency with a newly designed 1.65-ton truck, the GAZ-56.

(b)—The Consequences of Limited Variety

Extreme limitation of the variety of trucks necessarily leads to the use of some vehicles for tasks for which they are not well suited. Soviet studies show that the two basic trucks (GAZ-51 and ZIL-150) are poorly adapted to some of their primary tasks. A considerable number of these trucks see service in agricultural areas, yet can utilize only about 75 per cent of their carrying capacity (by weight) in hauling farm produce. Their bodies are too small for efficient use on the farm. The GAZ-51 cannot haul firewood economically, its body being too narrow for

SPECIFICATIONS OF BASIC SOVIET TRUCKS

TABLE III

	GAZ-51A	ZIL-150	ZIL-164	MAZ-200	YaAZ-210	MAZ-525
Dates produced	1946#	1946–1956	1957#	1946#†	1951#	1951#
Type	4 x 2	4 x 2	4 x 2	4 x 2	6 x 4	4 x 2, dumper
Maximum pay-load on paved road (tons)	2.8	4.4	4.4	7.7	13.2	27.5
Vehicle weight, equipped (tons)	3.0	4.3	4.5	7.0	12.5	26.9
Gross vehicle weight (tons)	5.9	9.0	9.1	15.0	25.9	54.6
Distribution of GVW:						
On front wheels, percent	30	26	26	26	19.5	34
On rear wheels, percent	70	74	74	74	80.5	66
Wheelbase (inches)	130	157	157	178	226	188
Length (inches)	225	265	264	300	380	329
Width (inches)	90	94	97	104	104	127

Engine	GAZ-51	ZIL-120	ZIL-120 (modernized)	YaAZ-204A	YaAZ-206A	V-2‡
Type	carb., 4-stroke	carb., 4-stroke	carb., 4-stroke	Diesel, 2-stroke	Diesel, 2-stroke	Diesel, 4-stroke
Number of cylinders	6	6	6	4	6	12
Cylinder bore (inches)	3.2	4.0	4.0	4.25	4.25	5.91
Piston stroke (inches)	4.3	4.5	4.5	5.00	5.00	left, 7.09; right, 7.35
Displacement (cu. in.)	212	339	339	284	425	2368
Compression ratio	6.2	6.0	6.5	16	16	15
Maximum horsepower	70*	90*	100*	110	165	300
Rpm at maximum hp	2800	2400	2400	2000	2000	1500
Maximum torque (lb/ft)	148	224	242	340	510	1114
Rpm at maximum torque	1500–1700	1100–1300	1100–1300	1200–1400	1200–1400	1100–1200
Engine weight, dry:						
Without clutch and gear box (lb)	562	948	948	1764	2116	2866
With clutch and gear box (lb)	694	1257	1257	2315	2822	4850
Gear ratios:						
First	6.40	6.24	6.24	6.17	6.17	7.14
Second	3.09	3.32	3.32	3.40	3.40	3.53
Third	1.69	1.90	1.90	1.79	1.79	1.88
Fourth	1.00	1.00	1.00	1.00	1.00	1.00
Fifth	—	0.81	0.81	0.78	0.78	0.72
Reverse	7.82	6.70	6.70	6.69	6.69	5.10
Final drive ratio	6.67	7.63	7.63	8.21	8.21	20.46
Turning radius (ft)	24.0	26.2	n.a.	30.2	41.0	34.1
Steering ratio	20.5	23.5	28.7	21.5	21.5	41.3
Maximum speed, fully loaded (mph)	43.5	40.4	46.6	40.4	34.2	18.6
Fuel consumption, fully loaded, on highway (mpg)	11.8	8.1	8.4	7.8	3.9	1.7
Operating fuel consumption norm (mpg)	8.9	6.2	6.2	6.7	n.a.	n.a.

Still in production.
* With governor.
† Date refers to first production of this truck by Yaroslavl' Automobile Plant under model number YaAZ-200. Production was transferred to the Minsk plant circa 1950.
‡ V-shaped at 60-deg angle.
n.a. Not available.
Primary source: *Yu. A. Dolmatovskiy and I. I. Trepenenkov, Traktory i avtomobili*, "Tractors and Automobiles", 2nd edition, Moscow, 1957.

the cross-wise loading of standard-length pieces, while lengthwise loading uses body capacity only in part. Such difficulties led to a redesigning and enlargement of this truck's body in 1956. The basic problem remains however, for the new trucks (called GAZ-51A) are produced with just this one body. Furthermore, GAZ-51 and ZIL-150 standard-model trucks are equipped with open bodies only, although 30 per cent of the freight hauled by motor transport in the USSR requires protection against the elements.

While some specialized adaptation, such as that produced by the Odessa Automobile Assembly Plant, has been developed, the most common attempted solution for difficulties arising from unspecialized design is for the State-operated motor pools to remodel vehicles themselves. This is often a necessity, for these establishments, after all, have their freight goals to meet. Generally the changes involve only a strengthening of the frame and suspension, or the manufacture and installation of roofing. But sometimes more extensive work, such as the lengthening of the chassis and the addition of a third axle, is required. These do-it-yourself remodelings are reported to be quite expensive and frequently of poor quality.

The dump trucks are also poorly adapted to much of their work. The dumpers most widely used in Soviet construction and quarrying are the 5.5 ton capacity MAZ-205 and the 3.9 ton ZIL-585. Both of these are simply adaptations of basic models, the chassis of which were not designed for dumping. They have both been found incapable of efficient utilization at construction sites. Body design and maneuverability appear to be the main problems. Similarly, the YaAZ-210E rear dumper has proven to be unsuitable for certain types of construction work because of its excessive turning radius.

Quite likely, it was problems such as these which caused the change in attitude noted above.

(c)—Special Fuel Trucks

The Soviets have long been interested in developing trucks which run on fuels other than gasoline and fuel oil. Compressed and liquefied gas, solid fuels (for wood-burning gas-producers and steam driven trucks), and electricity are in practical or experimental use. Soviet efforts in these areas appear to be motivated basically by a desire to conserve gasoline. Statistically, trucks powered by non-petroleum fuels are an insignificant percentage of the total annual output. However, compressed and liquefied gas fueled trucks appear to be of considerable future significance. GAZ and ZIL are turning out models of their basic trucks which run on compressed dry and liquefied-petroleum gases, and on manufactured gas. These have proven to be less economical to operate than the gasoline fueled GAZ-51 or ZIL-150. The bulky gas cylinders reduce the available freight capacity, operating speeds are lower, and engine horsepower is cut (by 20 per cent in the case of the GAZ vehicle and 13 per cent in ZIL's). The Soviets seem to feel that with relatively minor changes in the engine (e.g. a new cylinder head which would permit an increase in the compression ratio), these trucks can be run more economically than on gasoline. The development of genuine semi-Diesel engines is not, however, in evidence. Nine thousand trucks burning compressed gas and 11,000 using liquefied-petroleum gas have been scheduled for production in the Sixth Five-Year Plan (1956-1960). So far, they appear to have been most widely used in the Donbas region of the Ukraine, where both natural and manufactured gas are available.

2. PASSENGER CARS

(a)—Description of basic models

Passenger car production in the USSR consists almost entirely of three basic models (Table IV). They are the small 35-hp Moskvich 402, produced by MZMA; the somewhat larger 66-hp Volga-21G, manufactured by GAZ; and the GAZ-69A jeep, put out in Ulyanovsk. All have four-cylinder engines. Two modifications of these vehicles are also produced: a 4x4 cross-country version of the Moskvich and a combination of a Pobeda passenger car body and jeep engine, transmission, etc. (The Pobeda was recently replaced in production by the Volga-21G.) A small proportion of passenger car output consists of two heavier models, the ZIM and the deluxe ZIL-111. The ZIM, produced by GAZ, is referred to as a medium class car. It has a six-cylinder 95-hp engine and is used primarily for taxi—limousine and ambulance service. The ZIL-111, a "high class" car, has so far appeared only in experimental models. It has a V-8 210 hp engine, automatic transmission, hydraulic brakes with vacuum boosters, low pressure tubeless tires, wrap-around chrome bumpers, and more, no doubt. Large scale production is not anticipated. Complete specifications of the ZIL-111 are not yet available.

The Moskvich-402 and the Volga-21G are both new models of vehicles which had been in production for a decade. Comparison of these vehicles with their predecessors, the Moskvich-401 and Pobeda, respectively, indicates a trend toward heavier, more powerful, and more comfortable cars within the existing product-line structure.

The trend in engine design is characterized by increases in horsepower ratings, torque, piston displacements, compression ratios (to a high of 7:1), bore-to-stroke ratios (to a top of 1:1), and horsepower-to-displacement ratio. However, the number of cylinders in these cars' engines has not been increased, and L-head design is still used. The increases in engine power are primarily attributable to the increased displacement resulting from slightly larger cylinder bores. This, it should be noted, has become the basic direction of Soviet engine improvement. It is traceable to the limitation of compression ratios imposed by the poor quality of Soviet gasoline. The average octane rating of commercial gasoline in the USSR in 1956 was 65.

(b)—Design Trends of the New Models

The Moskvich 402 appears to be a much more comfortable vehicle than the 401. Its suspension has been improved, and telescopic double-acting shock absorbers in front and rear have been substituted for the single acting, lever type absorbers of the old Moskvich. The body has been enlarged, the glass area increased, and a heater and seats which convert to beds have been installed. Visibility, particularly of overhead traffic lights, has also been considerably improved. As to its exterior, the car's designer affirms that: "The body has been freed from temporarily modish elements and also from a superfluous number of chrome-plated decorations."

The Volga-21G is an intermediate model being produced only until the Pobeda's final replacement, the Volga-21, is ready for mass production. In addition to the engine changes already mentioned, the 21G is equipped with a central lubricating system for the front suspension joints and steering rods. This is the first such device to be installed on a Soviet vehicle. The car's dry weight is reported to be the same as that of the Pobeda despite its larger body. How a weight increase, similar to

TABLE IV

	Moskvich 401	Moskvich 402	Pobeda M-20	Volga M-21G (intermediate)	Volga M-21 (experimental)	ZIM	GAZ-69A (jeep)
Dates produced	1946-1955*	1956♯	1946-1956	1956♯	—	1951♯	1954♯
Seating capacity (incl. driver)	4	4	5	5	5	6	5
Weight, dry (lb)	1781	1984	2998	2998	3188	3968	3131
Distribution of weight, equipped and full:							
On front wheels, percent	47	49	48	n.a.	47	49.5	47
On rear wheels, percent	53	51	52	n.a.	53	50.5	53
Wheelbase (inches)	92	93	106	106	106	126	91
Length (inches)	152	160	184	190	190	218	152
Width (inches)	55	61	67	70	70	75	69
Height, road to roof (inches)	61	61	65	63	63	65	75
Engine	401	402	M-20	Modified M-20	M-21	ZIM-12	Modified M-20
Type	carb., 4-cycle	carb., 4-cycle	carb., 4-cycle	carb., 4-cycle	carb., 4-cycle	carb., 4-cycle	carb., 4-cycle
Valve arrangement	L	L	L	L	I	L	L
Number of cylinders	4	4	4	4	4	6	4
Cylinder bore (inches)	2.66	2.83	3.23	3.46	3.62	3.23	3.23
Piston stroke (inches)	2.95	2.95	3.94	3.94	3.62	4.33	3.94
Displacement (cu. in.)	65	74	129	148	153	212	129
Compression ratio	6.27	7	6.2	7	6.6	6.7	6.5
Maximum horsepower	26	35	52	66	70	95	55
Rpm at maximum hp	4000	4200	3600	3800	4000	3600	3600
Maximum torque (lb/ft)	40	52	90	116	123	155	92
Rpm at maximum torque	2000	2400	2000-2200	n.a.	2200	1600-1800	2100
Engine weight, dry:							
Without clutch and gear box (lb)	300	n.a.	430	n.a.	n.a.	551	430
With clutch and gear box (lb)	326	n.a.	551	n.a.	n.a.	683	551
Average piston speed (ft per min.)	1968	n.a.	2461	n.a.	n.a.	2618	n.a.
Gear ratios:							
First	3.53	3.53	3.115	3.115	2.73†	3.115	3.115
Second	1.74	1.74	1.772	1.772	1.56	1.772	1.772
Third	1.00	1.00	1.000	1.000	1.00	1.000	1.000
Reverse	4.61	4.61	3.738	3.738	2.08	3.738	3.738
Final drive ratio	5.14	5.14	5.125	4.62	4.44	4.55	5.125
Type of final drive	Spiral	Spiral	Spiral	Spiral	Spiral	Hypoid	Spiral
Clutch	S	S	S	S	—	S-H	S
Turning radius (ft.)	19.7	n.a.	20.7	19.7	n.a.	22.3	19.7
Tire size	5.00-16	5.60-15	6.00-16	6.70-15	6.70-15	7.00-15	6.50-16
Minimum road clearance (inches)	7.5	7.9	7.9	7.5	7.3	7.9	n.a.
Maximum speed, fully loaded (mi/hr)	56	65	65	75	75-81	78	56
Fuel consumption, fully loaded, on highway (mi/gallon)	29.4	33.6	21.4	n.a.	19.6-23.5	15.2	n.a.
Operating fuel consumption norm (mi/gallon)	26.1	n.a.	17.4	n.a.	n.a.	13.8	14.3

* The specifications of the Moskvich-400, produced during 1946-1951, differed in compression ratio (5.8), horsepower (23/3600), and gear ratios.
† These ratios apply to cars equipped with automatic transmission; the gear ratios of the standard transmission cars are the same as those of the Pobeda and their final drive ratio is 3.78.
S = Single disc, dry; S-H = single disc, dry, with hydraulic coupling.
n.a.—not available.
♯ Still in production.
Primary source: *Yu. A. Dolmatovskiy and I. I. Trepenenkov, Traktory i avtomobili* "Tractors and Automobiles," 2nd edition, Moscow, 1957.

SPECIFICATIONS OF BASIC SOVIET PASSENGER CARS

that of the Moskvich 402, was avoided is not explained.

The Volga M-21, experimental models of which have already been tested, is the most important new car. It is the first Soviet mass-production model to be equipped with automatic transmission and the first with a valve-in-head engine. Quantity production of the M-21 has been delayed by several defects in these new components which were revealed during road and laboratory tests.

The Volga M-21's automatic transmission consists of a hydraulic converter with a torque conversion ratio of 2.1:1 and a three-speed planetary gear box. Extensive use of these transmissions on mass-produced passenger cars in the USSR in the near future does not appear likely. An "official" position appears to be crystallizing, to the effect that they are both uneconomical (due to high manufacturing cost, complexity of repair, and poor fuel economy) and unnecessary (in view of the alleged operating convenience of the existing standard transmissions). At the outset, only 10 to 15 per cent of the new M-21's will be equipped with the automatic transmission. The available information indicates that this proportion will not be increased until the economic disadvantage of the automatic relative to the standard transmission is very greatly reduced.

The car's 70-hp engine also incorporates significant advances over the Pobeda. These include the aforementioned valve-in-head arrangement; adoption of an aluminum cylinder block; and a 1:1 bore to stroke ratio, both dimensions equalling 3.62 in. The displacement (150 cu in.), compression ratio (6.7), and torque (123 lb ft) of the four-cylinder engine also represent increases over the Pobeda. The M-21 also has the central, pedal-operated, lubrication system of the M-21G. Thus, the Pobeda to Volga M-21 model change is a relatively extensive one. It was originally planned also to install an all-new valve-in-head engine in the Moskvich-402, but this proposal has apparently been shelved.

(c)—Public Reaction and Prices

Design trends for Soviet passenger cars are now clearly pointed in the direction of the somewhat larger and more powerful cars typical of Western Europe. There appears to be no present intention to emulate American cars in size and power. Public reaction to this trend of design has not been entirely favorable. The reason is that bigger and better cars cost more to make and to buy. The prices of the Pobeda, the new Volga, and Moskvich are such as to require years of saving before the average Soviet worker can pay for one. The new Moskvich, the smallest of the lot, sells for 15,000 rubles, about a year and a half's

TABLE V

SPECIFICATIONS OF BASIC SOVIET BUSES

(The list of specifications in this table is incomplete. Other specifications applicable to these vehicles appear in table III)

	PAZ-651[a] (service)	ZIL-155[b] (city)	ZIL-158[c] (city)	ZIL-127[d] (intercity)
Dates produced	1952#	1952-1957	1956#	1955#
Capacity:				
Seated	19	28	32	32
Standing	4	22	28	—
Vehicle weight, empty, equipped (lb)	8,270	13,870	14,240	20,945
Gross vehicle weight (lb)	12,235	23,015	24,030	27,560
Distribution of GVW:				
On front wheels, percent	27	38	36	n.a.
On rear wheels, percent	73	62	64	n.a.
Wheelbase (inches)	130	161	191	220
Length (inches)	243	325	355	402
Width (inches)	93	98	—	106
Height (inches)	103[e]	116[e]	—	119
Engine	GAZ-51	Modified ZIL-120	Modified ZIL-120	YaAZ-206D
Maximum horsepower	—	95	112	180
Rpm at maximum hp	—	2,800	3,000	2,000
Maximum torque (lb/ft)	—	242	250	550
Rpm at maximum torque	—	1,100	n.a.	1200-1400
Compression ratio	—	6.0	6.5	16
Gear ratios:				
First	—	—	—	6.17
Second	—	—	—	3.40
Third	—	—	—	1.78
Fourth	—	—	—	1.00
Reverse	—	—	—	8.12
Angular drive	—	—	—	1.158
Final drive	—	9.29	—	3.64
Tire size	—	10.00-20	—	320-20
Maximum speed, fully loaded (mi/hr)	43.5	40	n.a.	59
Fuel consumption, fully loaded, on highway (mi/gallon)	10.7	6.5	n.a.	5.9

[a] Specifications not shown are the same as those of the GAZ-51 truck.
[b] Specifications not shown are the same as those of the ZIL-150 truck.
[c] Specifications not shown are the same as those of the ZIL-155.
[d] Engine specifications not listed are the same as those for the YaAZ-206A engine.
[e] Height of empty bus.
n.a. Not available.
Still in production.
Primary source: *Yu. A. Dolmatovskiy and I. I. Trepenenkov, Traktory i avtomobili*, "Tractors and Automobiles," 2nd edition, Moscow, 1957.

wages for the average worker in the Soviet automobile industry. (The wage level in this industry is significantly above that of Soviet industry in general.) The price of the new ZIL-111 is reported to be 70,000 rubles ($17,500 at the official rate of exchange, or $7,000 at the more realistic tourist rate). This would be more than seven years' wages for an average industrial worker.

What is needed therefore is not larger and more expensive cars, but even smaller, cheaper ones. The general specifications of such cars, as recently proposed by one engineer, are the following: four-passenger body, 40 to 52 cu in. engine displacement (or only about 60 per cent of that of the new Moskvich), 20 to 30 hp, total equipped weight of 1300 lb (also about 60 per cent of the new Moskvich figure), top speed of 50 to 60 mph, and more economical design (e.g. two doors instead of the four which are standard on all Soviet passenger cars). Letters from the Soviet man in the street, which have been published in the press, express the view that this engineer is on the right track, but that he does not go far enough. These readers, understanding the realities of the Soviet metal shortage and production priorities, suggest such measures as plywood bodies, do-it-yourself automobile assembly kits, and, quite frequently, micro-cars built around motorcycle engines. (The Bulgarian Sofia-12 is such a car.) Omitted from these discussions is the fact that the retail prices of Soviet passenger cars are not derived directly from their costs of production, but are based largely upon so called "capitalistic" calculations of supply and demand. However, to the extent that manufacturing cost does affect car prices (as a minimum, at least), and to the extent that metal consumption affects their volume of production, it is clear that passenger car design in the USSR is moving in the wrong direction from the would-be consumer's point of view.

3. BUSES

The variety of buses produced in the USSR is also limited. At the present time only three models are in quantity production (Table V). These are a 19-passenger service bus (PAZ-651); a 28-passenger city bus (ZIL-155); and a 32-passenger intercity bus (ZIL-127).

(a)—ZIL-155 City Bus

By far the most important of these vehicles is the ZIL-155, the second postwar Soviet bus. The first was the ZIL-154, a 34-passenger model powered by the YaAZ-204A Diesel, which first appeared in 1947. Its engine contaminated city streets with excessive fumes, and production of the bus was discontinued after several years. The ZIL-155 came out in 1949 and was soon being produced on an unprecedented scale. By mid-1955, ZIL-155's represented 60 per cent of all buses in general service in the USSR.

The ZIL-155 has several basic defects originating in the general Soviet automotive ailment, lack of vehicle specialization: its chassis and engine are basically those of the ZIL-150 truck. Operationally, its basic shortcoming is that its capacity is only about 60 per cent of what efficient transit service requires in a large Soviet city. It is eventually to be replaced by a larger bus called the ZIL-129. Unfortunately, recent tests of experimental models of the latter vehicle revealed serious defects in many of its components. Rather than continue production of the ZIL-155 in its present form while the ZIL-129 was being improved, a short run "modernized" version of the 155,

the ZIL-158, was recently put into production.

In the ZIL-158, bus capacity has been increased by 20 per cent through the addition of one window section of length, and engine power has been raised to 105 hp by installing a new cylinder head. The vehicle admittedly retains the basic defects of the ZIL-155, and the ZIL plant has been enjoined to make haste with the ZIL-129. Another ZIL-150 modification is the "Lvov," a 34-seat bus which recently went into production at LAZ. It has the standard, heavy, ZIL truck chassis and engine (stepped up to 109 hp), but represents a more thorough remodeling job than the ZIL-158. The biggest difference is that the Lvov's engine is located in the rear.

(b)—ZIL-127 Intercity Bus

The ZIL-127 intercity bus is of comparatively recent origin. It was designed and tested in 1955, the first lot coming out in the latter part of that year. It is powered by a 180 hp Diesel engine located in the rear. The Soviets claim that in basic parameters it compares not unfavorably with contemporary American intercity buses. On the other hand, they acknowledge that U. S. buses of similar dimensions have considerably greater seating capacity.

Although several defects in its design were revealed in tests, many of the shortcomings were attributed not to deficiencies of the vehicle itself, but to exceedingly poor road conditions. This is particularly significant since the bus was tested on the Moscow-Kharkov route, one of the most vital in the USSR. In many places the roads were found to be too narrow, the shoulders in very poor condition, and snow removal in winter highly inadequate. (The last problem was accentuated by the very poor performance of the brakes on snow.) Particularly troublesome were the junctures of roads with bridges. Ruts and holes in these areas necessitate sharp reductions in speed and subject the bus to considerable strain. As a result of these generally poor conditions the bus can rarely make use of its top speed of 60 mph. In addition, there is an almost total lack of service facilities. In October 1956, there was reported to be only one service station on the 500 mile route between Moscow and Kharkov. It was located at Mtsensk, about 200 miles south of Moscow. Roadside passenger facilities were also almost non-existent, and those that were available are described as unfit for use. Overall it appears that the bus itself and the long distance intercity service for which it was designed are somewhat beyond the capabilities of some of the existing Soviet highways.

(c)—PAZ-651 Service Bus

The PAZ-651 service bus has been in production since 1952. It uses the GAZ-51 (truck) chassis and 70 hp engine. It is used on low volume urban and suburban routes and as a service vehicle by airports, resorts, sanatoria, and other institutions. The bus' usefulness is limited by its small capacity, namely 23 passengers. At last report the Pavlovo plant was preparing for serial production of an enlarged, more powerful model called PAZ-652. This vehicle also consists primarily of GAZ-51 components.

IV

The Basic Problem: Lagging Technology

A Introduction

The Soviets have pointed to their automobile industry, throughout almost all of its 25-year history, as one of the greatest achievements of their socio-economic system. In scale, organization, and production technology this industry has been hailed as the most advanced branch of Soviet industry and the equal of anything the rest of the world had to offer. The assertion, vis-a-vis other Soviet industries, certainly was justified for a great many years; in certain respects it is still true. As to the broader comparison, the Soviet claims may have been valid during the industry's early years when its plants were new and modeled after the best plants of the Western world, but they certainly are not today. Now the industry lags, and the change in position did not come about overnight. What has developed of a sudden is a certain frankness in dealing with it. The following two quotations from a Soviet technical newspaper summarize the trend and the current position of this industry:

> "Until comparatively recently, the technology of automobile production was among the most advanced in Soviet machine building. At the present time, however, it is quite backward relative to the level achieved by other branches of our industry and to that of contemporary world technology." Promyshlenno-ekonomicheskaya gazeta (Industrial-Economic Gazette), February 3, 1957.
>
> "Against a background of rapid growth of other branches of machine building, the backwardness (of the automobile industry) becomes ever clearer; gradually the situation of the automobile industry has come to be characterized by the very unpleasant word, stagnation." Ibid., November 14, 1956.

This backwardness has made itself felt in three basic areas: the quality of the vehicles produced, the technology of their production, and the organization of labor within the plants. Before proceeding to examine these aspects, a brief discussion of the background of the situation may prove helpful.

The major automobile plants, as well as other large machine building establishments of the USSR, were set up as complete-cycle operations. They have their own forging and casting shops, machine shops, and assembly shops. They also have extensive tool-making and repair shops. The former manufacture a large part of the plants' machine tools and the latter make spare parts for this equipment. In addition, there are shops making the countless small standard items necessary to a machinery enterprise. This unspecialized industrial structure was necessitated by the lack of development of standardization and interchangeability of products and parts within the entire machine building sphere. Standardization was retarded by the fact that the prevalent scales of production were generally insufficient to justify additional investment in precision tools. The installation of less productive, less precise machinery therefore contributed to the development of highly self-contained establishments and discouraged standardization on a nationwide scale.

This unspecialized machine building industry has been operating under a highly centralized system of control and direction. Under this system (only recently abolished) the most minute aspects of plant operation were controlled by a ministry in Moscow. The authority of

the plant director was, and still is, very restricted. This arrangement has proved highly unsatisfactory. The separation of direction from operation, in both time and space, has resulted in the poor performance of both functions.

The basic means of direction was a multiplicity of goals, set by the ministry, to be achieved by the plant. These goals covered virtually every aspect of plant operation. On the basis of the plant-wide goals, targets were set for each shop. The plant's progress in achieving its goals was checked through the mechanism of monthly reports submitted to the ministry. Formulas provided for specific financial rewards to those responsible for the fulfillment or overfulfillment of their goals. Certain of the goals were more important than others, and this was reflected in the reward system. Generally, the most important target has been the one concerning gross value of output (in ruble terms). After it come physical production in the planned product-mix, cost of production, labor productivity, economies of metal, and a host of others. However, gross value of output is the predominant goal.

As this system evolved, it developed characteristics and tendencies which affected operations within the ministry and within the plant, and in fact, the development of Soviet industry as a whole.

(a)—Because of its complexity, its dependence on increasingly undigestible masses of statistics, and its inability to anticipate innovations, centralized planning for a large number of establishments has become largely mechanical. The goals are based primarily on averages of performance during the preceding reporting period and do not reflect the specific conditions of individual plants. This is confirmed by current Soviet self-criticism.

(b)—The heavy reliance upon statistical reports for control and for the distribution of rewards has brought about a basic orientation toward quantity rather than quality.

(c)—The primacy of the gross value of output goal has resulted in concentration upon its fulfillment at the expense of cost of production and the product variety required by consumers.

(d)—The frequency with which the operating reports are submitted, the frequency with which the incentive system is readjusted, and the speed of rewards or punishments have created a tendency to maximize *immediate* production. This often involves resistance to technological improvements of long-run value.

(e)—Within ministries and trusts, the interests of plant management tend constantly toward isolation from those of the parent organization. This is also true, but to a lesser degree, of the interests of the shop relative to those of the plant of which it is a part.

(f)—Being conscious of the fact that the plants of other ministries and even those of its own ministry have the same narrow interests, plant directors avoid dependence upon other establishments for parts or supplies wherever possible. They much prefer the additional cost of small-scale parts production within their own plants to the risk of production breakdown because of a supplying plant's failure to cooperate. This, in turn, contributes to the perpetuation of the present, insufficiently specialized, organization of industry.

The overall effect of these factors has been to create an atmosphere in which everyone, from the plant director to the ordinary machinist, is basically motivated toward the fulfillment of his own periodic production goal in the units or terms used on the reporting form. Everything else becomes secondary. This narrow, mechanical approach is known in the Soviet jargon as "formalism." Its operation within the automobile industry is largely responsible for that industry's present-day stagnation. To be sure, the industry has also been handicapped from without. The basic external factors have been lack of specialization throughout the machine building sphere; shortages of capital and technicians; and, perhaps most important of all, an inescapable area of dependence upon other industries which, in varying degrees, have also experienced the debilitation of formalism.

B General Evaluation of Soviet Motor Vehicles

Current Soviet motor vehicles are acknowledged by their manufacturers to be inferior to comparable American and European models. They are characterized by outmoded design, excessive weight, generally high fuel consumption, and uneconomical operation. For many years these conditions, particularly excessive vehicle weight, were officially explained as a deliberate policy designed to guarantee dependable service under the arduous road and climatic conditions of the USSR. Today it is admitted that this claim is untrue; it is dismissed as a product of the "period of the flowering of the cult of personality."

1. TRUCKS

Table VI presents weight and power functions of the four most common Soviet trucks and of four current American trucks which have been selected for their similarity of type and engine. The relatively great chassis weights of the Soviet trucks are apparent. In this regard, the vehicle most frequently criticized by the Soviets (including Marshal Bulganin) is the ZIL-150. Its chassis weight is more than a ton greater than that of Studebaker trucks of the same capacity. A Soviet study of 65 comparable American trucks showed the sample's average payload-to-chassis weight ratio to be 2.15, with only 5 of the trucks having ratios below 2.00. The ZIL-150's ratio is only 1.77. The other Soviet trucks have also been found to be overweight relative to contemporary European and American designs but not nearly to the extent of the ZIL-150. (The GAZ-51's ratio is 1.90.)

The excessive weights of the Soviet trucks are not concentrated in any one component or section of the vehicle, but are distributed throughout from engine to wheels. The causes are the limited use of stronger alloys (rather than carbon steel) and of nonferrous metals; poor geometrical design, and lagging production technology. However, especially extensive weight reductions would be attainable through wider utilization of alloy steel and nonferrous metals in the heavier aggregates, such as the engine, frame, and body. The metal weight per horsepower of the ZIL-120 engine is approximately twice that of comparable foreign engines and the YaAZ-204's is about 50 per cent greater than that of American Diesels of the same type, according to Soviet data. The use of alloy steels or modified iron for the cast parts, particularly of the ZIL-120, would greatly reduce this deficiency. Wider use of aluminum also offers considerable promise. These and many other possibilities are frequently mentioned in Soviet technical literature, but it does not appear likely that they will be exploited in the immediate future. The supply of the required metals is apparently strictly limited and automotive designers do not appear to be counting on a great change in the present variety of materials available to their industry.

Poor design also contributes to the weight problem. The effect of nonspecialized body design upon capacity utilization has already been mentioned. No attempt to

TABLE VI

Make and Model	Brief Description	Chassis Weight (lb)	Gross Vehicle Weight (lb)	Chassis Weight as Percent of Gross Vehicle Weight†	Horse Power Per Ton Of Chassis Weight	Horse Power Per Ton Of Gross Vehicle Weight
U.S.S.R.						
GAZ-51	4x2, dual rear, gas engine, 6 cyl., 70 hp	4,492	11,817	38.0	31.2	11.8
ZIL-150	4x2, dual rear, gas engine, 6 cyl., 90 hp	6,706	18,155	36.9	26.8	9.9
MAZ-200	4x2, dual rear, 2-stroke Diesel, 4 cyl., 110 hp	11,762*	30,038	39.2	18.7	7.3
YaAZ-210	6x4, dual rear, 2-stroke Diesel, 6 cyl., 165 hp.	20,607	51,863	39.7	16.0	6.4
United States						
Dodge, K6-D400	4x2, dual rear, gas engine, 6 cyl., 125 hp.	3,875	15,000	25.8	64.5	16.7
Studebaker, 3E17B	4x2, dual rear, gas engine, 6 cyl., 106 hp.	4,185	18,000	23.3	50.7	11.8
Reo, A-703D	4x2, dual rear, 4-stroke Diesel, 6 cyl., 175 hp.	9,970*	30,000	33.2	35.1	11.7
FWD, 6-609D	6x4, dual rear, 4-stroke Diesel, 6 cyl., 200 hp.	18,990	60,000	31.6	21.1	6.7

† In comparing Soviet and U. S. chassis weights to gross vehicle weights there is a very slight bias in favor of the U. S. vehicles caused by the fact that the latter's chassis weights include the weight of standard sized tires whereas their gross vehicle weights assume the use of the maximum authorized tire size. The U. S. chassis weight figures are therefore understated by the weight excess of maximum authorized over standard sized tires.

* Includes weight of cab.

Primary sources: Soviet trucks — table III and B. V. Gol'd, *Proyektirovaniye avtomobiley* "Design of Automobiles," Moscow, 1956, chapter II.
U. S. trucks — "Automotive Industries, 39th Annual Statistical Issue," March 15, 1957, pp. 142, 144, 146.

WEIGHT AND POWER CHARACTERISTICS OF BASIC SOVIET AND SIMILAR CURRENT U. S. TRUCKS

increase vehicle utility through cab-over-engine design has yet been made. Numerous specific parts have been designed without regard to their mass. One example is the use of heavy, double disk clutches on medium sized trucks while the single disk type is considered satisfactory on heavier trucks (MAZ-200 and YaAZ-210).

The poor fuel economy of Soviet trucks is frequently criticized in the press. Both the vehicles themselves and the quality of the available gasoline are to blame. Neither of the basic gasoline-burning trucks is equipped with either an auxiliary transmission or a second set of gears on the single final drive. Some Western trucks equipped with these accessories have achieved significantly improved mileage per gallon. The particularly poor fuel economy of the ZIL-150 is attributed to its K-80 carburetor which is badly designed and was not properly tested before installation. To the extent that fuel consumption is a function of the engine's compression ratio, Soviet gasoline burning trucks are at a disadvantage. The unfortunate aspect of this situation, from their point of view, is that higher compression ratings demand higher octane fuels. The "big two" Soviet trucks, the GAZ-51 and ZIL-150, with compression ratios of 6.2 and 6.0 respectively, use 66 octane gasoline. The new, modernized versions will probably burn 70 octane fuel. The higher compression ZIM passenger car uses 74 octane gas and, accordingly to recently adopted All-Union Standard (GOST) specifications, 72 and 76 octane fuel is also to be produced. The technological level of the Soviet petroleum refining industry raises doubts, however, concerning the quality and quantity of the higher octane fuels that will be produced. A recent Soviet source summarizes the situation as follows: "A sharp increase in the octane rating of Soviet automotive gasoline will require the adoption of new petroleum processing methods and a basic reconstruction of the petroleum industry. Therefore, until this problem is solved, the design of future automobile engines should assume an increase of only from 66 to 70 in the octane rating of standard Soviet gasoline."

The operational durability of the Soviet trucks is difficult to evaluate. Scattered information indicates that it is not too high. The YaAZ-204 and 206 Diesel engines usually need repair after less than 20,000 miles. The unlined cylinders of the ZIL-120 engine are said to wear out rapidly and the GAZ-51's crankshaft frequently causes trouble requiring engine overhaul. However, quantitative evaluation of this sort of data is impossible. Perhaps of greater significance is the fact that over one-quarter of the USSR's truck park is constantly in disrepair. Inadequate servicing and shortages of spare parts contribute to this proportion, but the quality of the original vehicles must also be a factor.

The shortcomings and obsolescence of the Soviet trucks are attributable to several factors. First is the fact that the automobile industry itself is not very interested in innovation. Those who should be interested, the chief automotive designers, have become, in Soviet words, "the simple executors of orders from the plant administration or the ministry." The remaining designers are kept busy with production problems. This is readily understandable since their pay depends on the success of the plant's production program and not on design work. Their attitude is reflected in the completely inadequate production and testing of experimental models. Frequently, decisions are made on the basis of a single model and testing is made difficult by the complete absence of automotive proving grounds in the USSR. Also significant is the industry's failure to provide sufficient spare parts, especially parts of up-to-date design. Even if the industry's spare parts plan for 1956 had been fulfilled (it apparently was not), only 78 per cent of the actual demand would have been met. Furthermore, in producing parts, the automobile plants concentrate on production of the more highly valued parts in order to fulfill their gross-value-of-output plan. This approach has even resulted in the receipt by trucking concerns of pistons of one size and rings of another simply because a plant specializing in pistons did not find it "convenient" to convert its machinery to the new size.

Model changes are very infrequent because of the difficulty and cost of retooling and the unavoidable disruption of production which accompanies it. The automobile plant is compelled to manufacture virtually all the required equipment and tools itself. This must be done in limited serial production, largely on universal machine tools, and with a large proportion of manual labor. The weight problem has been aggravated by a protection from criticism afforded by the "strength-through-weight" theory. The Soviets are now considering incentive programs which will offer designers monetary rewards for

TABLE VII

	Moskvich 401	Moskvich 402	Pobeda M-20	Volga M-21G	Volga M-21 (automatic transmission)	U. S. Average 1956
Design:						
Bore to stroke ratio	0.90	0.96	0.82	0.88	1.00	1.02
Displacement per cylinder (cu. in.)	16.3	18.6	32.3	37.0	37.4	39.6
Hp per cu. in. of displacement	0.40	0.47	0.40	0.45	0.47	0.69
Hp per ton of dry weight	29.2	35.3	34.7	44.0	43.9	108.7
Displacement per ton of dry weight (cu. in.)	73.3	75.0	86.3	98.7	93.8	173.8
Performance:						
Acceleration—time required to cover 100 meters (328.1 ft) from standstill (seconds)	12.3	10.8	11.5	n.a.	12.7[a]	*
Time required to reach speed of 60 km. (37.3 miles) per hour from standstill (seconds)	28	18	16.4	n.a.	17.5[b]	*
Maximum speed (miles per hr.)	56	67	65	75	79	*
Fuel consumption:						
Optimum performance (miles per gal.)	31.8	37.3	26.1	n.a.	27.7	*
On flat paved highway, 30 mph (m/g)	30.2	27.7	n.a.	23.5[c]	n.a.	*
In city traffic (m/g)	22.4	24.0	17.7	n.a.	17.2	*

[a] 10.2 seconds for Volga equipped with standard transmission.
[b] 11.3 seconds for Volga equipped with standard transmission.
[c] Fully loaded (5 riders), level highway, 25–31 mph.
* Not comparable. For a discussion of comparable European cars, see text.
Primary sources: *Avtomobil'nyy transport*, "Automotive Transport," No. 1, 1956, pp. 23, 24; No. 4, 1956, pp. 26–29; No. 2, 1957, p. 28; and "AUTOMOTIVE INDUSTRIES, 39th Annual Statistical Issue," March 15, 1957, p. 116.

COMPARATIVE DATA ON SOVIET PASSENGER CAR DESIGN AND PERFORMANCE

the discovery of ways to reduce vehicle weight. The size of the reward would vary directly with the absolute weight reduction effected per vehicle. One plan proposed a rate of 1 ruble per gram. A detailed Soviet study of the ZIL-150 indicates that its weight can be reduced by about 750 lb solely through improved geometric design of basic components and without the increased utilization of light alloys. Such an improvement would bring a reward of about 350,000 rubles at the suggested rate.

Another important factor in the obsolescence of design is the variety of goods available from other industries. The Lvov Bus Plant (LAZ) recently designed a bus which was to have more seats than the ZIL-155 and yet be lighter. This was to be achieved through the use of lighter materials such as sponge rubber instead of spring seats, thinner window glass, and lighter tires. As it turned out, the sponge rubber seats obtainable from the Ministry of the Chemical Industry were four times heavier than comparable seats being produced in Italy; the glass available from the Ministry of the Construction Materials Industry (in 6 and 8 mm thicknesses only) brought the bus' glass weight to a figure 84 per cent above that of a comparable English bus; and the hoped-for lighter tires proved unobtainable. Just these three factors brought the bus' weight to half a ton more than planned. The sponge rubber seats, incidentally, were not installed at all. As it turns out, the bus apparently will have the same seats as the ZIL-155. These have been described as being of such poor quality "that it is a shame to put them in a new bus."

2. PASSENGER CARS

The aim of recent model changes in passenger cars has been to reduce their technological backwardness to the maximum extent possible under the conditions imposed by Russia's climate, roads, raw materials priority system, and technological level in related industries. So far, the Soviets appear to have been partially successful in achieving this goal.

The modernization of the Moskvich-401 is an excellent case in point. This car, which was produced through 1955, is admitted to be of 1937-1938 design. It is distinguished by extremely low horsepower to weight and horsepower to displacement ratios, poor acceleration, relatively high fuel consumption, a small, uncomfortable body, poor visibility, and generally poor riding qualities. The improvement which has been realized in the 402 is impressive in some areas and negligible in others. One of the goals of the vehicle's modernization was to increase its horsepower to displacement ratio from 0.40 to the contemporary European small car level of 0.54-0.61 hp per cubic inch. The new 402's ratio is only 0.47, lower than that of any of the 11 4-cylinder European cars against which the Soviets tested it. So far as this engine parameter is concerned it appears that somewhat less than half of the gap has been closed.

The vital weight to power relationship presents a similar picture. The Moskvich 401 was particularly criticized for its very low ratio of 20.5 hp per ton of loaded vehicle weight. The 11 car models with which comparison was made have an average ratio of 30.5 hp per ton, with only 2 of the 11 having ratios below 28 hp per ton. The new 402's ratio, on the other hand, has been increased to only 24.8 hp per ton, lower than that of any of the 11 and one of the very lowest in the world. (According to data given by the AUTOMOTIVE INDUSTRIES annual statistical issue for 1956, only the Japanese produce 4-cylinder, carburetor engine passenger cars with lower horsepower to weight ratios.) Again, less than half of the lag has been overcome.

Acceleration, as shown by Table VII, has been considerably improved but is also not quite up to European standards. Of the four foreign cars for which comparable test data are given by the Soviets, three had superior acceleration (Fiat-1100, Simca-Aronde, and Ford Consul) and one was slightly inferior (Hillman-Minx). Fuel consumption cannot be said to have been improved significantly, if at all. Tests showed that the 402 gave fewer miles per gallon than the 401 under a variety of speed and road conditions. Only in Moscow city traffic was the new car superior. Relative to the European cars, the 402 excelled the Ford Consul under all test conditions, and the Ford Taunus and Hillman-Minx under some conditions. It proved inferior to the Fiat-1100 and Simca-Aronde under all conditions. The 402's shortcomings in this regard are attributed to imperfections in its carburetor which were to be worked out before mass produc-

tion began. Overall, the new car is admitted to be significantly behind contemporary European small cars in engine and operating characteristics. The source in which the test results were reported expressed confidence that this lag would be overcome by a new valve-in-head engine still in the designing stage. A later article on the 402 by its designer, A. F. Andronov, made much of the vehicle's improved comfort and riding qualities but failed to mention this new engine. It therefore does not appear to be in prospect for the immediate future.

Three experimental models of the Volga M-21 have also been tested against various foreign cars. The former proved deficient in fuel economy, acceleration, and various engine characteristics. Its speed and riding qualities were judged fully satisfactory. The primary defect of the Soviet car again proved to be excessive weight. The M-21, at 3188 lb (dry wt), is one of the heaviest 4-cylinder cars in the world. Its horsepower to weight ratio of 43.9 hp per ton of dry weight, while considerably above that of the Moskvich 402, is very low for a car of this size. (The average ratio of four European cars considered comparable by Soviet sources is 55.3 hp per ton.) This, in turn, has had an adverse effect upon acceleration and fuel economy. The Volga equipped with automatic transmission required 12.7 seconds to cover 100 meters from standstill compared to 11.5 seconds for a Ford-6 (1954) and 10.0 seconds for a Chevrolet (1953), both of which also had automatic transmissions. When equipped with standard transmissions, the Volga's acceleration was much better: it made the 100 meter trip in only 10.2 seconds, compared to 11.5 seconds for the Pobeda, 10.5 seconds for the ZIM, and 11.0 seconds for the British Standard-Vanguard (1952). The Volga's fuel consumption is about the same as that of the Pobeda. It is not considered satisfactory, but weight reduction is expected to result in significant improvement.

In addition to excessive weight, defects of the engine and automatic transmission contribute to the Volga's unsatisfactory performance. The engine has shown a tendency to knock even when burning 70 octane fuel. It also suffers significant torque loss (19 per cent from maximum) and concurrent increases in fuel consumption when operated in the low rpm range (1100-2000). The new engine's horsepower to displacement ratio, 0.47 hp per cubic inch (the same as that of the Moskvich-402 and about the U. S. average in 1951) is also relatively low. Both engine and transmission are to be improved before quantity production is undertaken.

3. BUSES

Soviet buses suffer from the same general disadvantages as the trucks on which they are based, but to a greater degree. According to its specifications, the ZIL-155's gross vehicle weight is 11.5 tons. During rush hours its total weight actually exceeds 12.5 tons as 37 to 40 standees crowd aboard instead of the official limit of 22. The bus' engine, however, is only slightly more powerful than that which has been found inadequate for the 9 ton (GVW) ZIL-150 truck. The horsepower to weight ratio of the ZIL-155 empty (but equipped) is only 13.7 hp per ton; comparable American city buses have considerably higher ratios (e.g., the Fitzjohn F16 City liner, which seats 29-31, has a dry weight of 6 tons and a 131 hp engine for a ratio of almost 22; and GMC model TCH-3102 has a ratio of 25.7. Note that the U. S. margin is slightly exaggerated due to the comparison of equipped weight with dry weight.) As a result, the ZIL-155 is incapable of as rapid or as economical service.

This bus has other defects, as well. The propeller shaft vibrates so badly as to shake the body apart (in addition to rattling the passengers), the gear shift is very difficult to operate and causes severe driver fatigue, ventilation is poor, and the bottom step is so high off the street as to raise a Muscovite's ire before he even pays his fare.

The ZIL-127, to quote one Soviet source, "is definitely not a success." Tests revealed various defects, such as loose body construction, insufficient cooling of gear box and engine oil, and the inaccessability of various parts requiring frequent check and adjustment. The vehicle's primary shortcoming is its YaAZ-206D Diesel engine, which is relatively short lived. Of the 19 ZIL-127's in use in Moscow in mid-1956, the engines of three had to be replaced before the minimum guaranteed mileage (19,000) had been reached; nine were replaced after runs of 29,000 to 44,000 miles and only seven were still in service after 47,000 miles. (The chief engineer of the transit division involved considers a minimum inter-repair run of 93,000 miles essential.)

In evaluating all of these vehicles, the limitations under which the Soviet automobile industry operates should be kept in mind. The generally woeful quality of the Soviet Union's roads necessitates a sturdier, heavier construction (particularly of frame and undercarriage) than suffices in most of the Western world. While heavier weight is now admitted to have been long exploited as an alibi for poor design and engineering, it is also clear that the Soviets do have a genuine need for very sturdy vehicles.

Compulsory dependence upon often uncooperative, technologically backward, related industries is another major handicap. The effect upon engine design of the generally poor-quality gasoline available in the USSR has already been mentioned. The metallurgical industry has been particularly criticized for the poor quality steel which it supplies to the automotive plants. The most frequent complaints are of rough surfaces, insufficient hardness, and excessive carbon content. To make matters worse, the steel plants' attitude often leaves much to be desired from the consumer's point of view. When several automobile plants recently complained to the Krasnyy Oktyabr' (Stalingrad) and Chelyabinsk metallurgical plants that the steel they were receiving was untempered, whereas the auto plants' need was for tempered alloy steel, the former dismissed the complaint with the suggestion that the automobile plants temper the metal themselves. The Ministry of the Chemical Industry is another culprit, supplying brake linings which have friction coefficients only 60-80 per cent as great as those of western brake linings. Body paints are of inferior quality and poor durability, control gauges are inaccurate, and no special winter grade lubricants are available for civilian uses. Directly or indirectly, the quality of Soviet automobiles is being adversely affected by these circumstances. So far there has proven to be relatively little that the automobile industry can do to correct them.

C Production Technology

Production technology in the Soviet automobile industry is considerably behind the levels achieved in the West. This is conceded by the Soviets and confirmed by Western visitors to their major automobile plants. Their technology is at its best in metal cutting but lags particularly in metal forming and auxiliary activities. First steps have been taken in automation, but serious and as yet unresolved difficulties have been encountered.

1. METAL CUTTING

The machine-tool park of Soviet industry as a whole is older than that of the United States, for a high rate of new installations has not been balanced by timely retirements. In 1955, an official survey showed that 60 per cent

of all Soviet machine tools were more than 10 years old, the comparable figure for the United States in 1953 being 56 per cent. The average age of industrial equipment in the Soviet automobile industry is even greater. In his speech to the Supreme Soviet on May 7, 1957, Communist Party Secretary Khrushchev called attention to the large amount of obsolete equipment in use at GAZ and ZIL. Many of the machine tools in the former plant are 10 to 20 years old and of outmoded design. As of March 1, 1955, 76.3 per cent of ZIL's machine-tools and metal-forming equipment were more than 10 years old. The corresponding figure for MZMA as of January 1, 1957 was 63.7. In some of the new plants, the average age of equipment is undoubtedly lower. However, Ural ZIS, largely tooled with equipment evacuated during World War II from ZIL (then ZIS), must have elderly machinery indeed.

Nevertheless, the technological level of the automobile industry's basic machine shops probably surpasses that of any other major branch of Soviet machine building. In general, most obsolete, low-capacity equipment has been relegated to the auxiliary shops. Automatic and semi-automatic machine tools represented about 42 per cent of the total park in basic machine shops at ZIL and about 55 per cent at GAZ in 1955. The advanced status of these basic machine shops is indicated by the fact that such tools represented only 7.9 per cent of all metal-cutting tools in all shops at ZIL in 1955, and at MZMA on January 1, 1957. In 1956, automatic and semi-automatic tools comprised only 6.3 per cent of the entire machine-tool park of the Soviet Union. The basic production shops of the automobile industry also command a large proportion of Russia's automatic machine-tool lines. The automobile industry has been the leader in aggregating universal machine tools and connecting them through automatic materials-handling lines, thereby creating reasonably inexpensive automatic production lines. As of mid-1956 there were approximately 100 automatic machine-tool lines operating in the Soviet machine-building industries. Toward the middle of 1957 GAZ alone had more than 50, ZIL had 10, and there were some at MAZ, MZMA, and several specialized parts producers. It should be noted that the Soviet automobile industry as a whole had only two such lines in 1945. Overall, it appears that the technology of the automobile plant's basic machine shops has been the subject of long-standing emphasis and is still outstanding in Soviet industry.

2. METAL FORMING

Such is not the case in the pressure processing of metal. The modernization of press-forging and casting equipment and techniques has been largely ignored by the automobile industry. Powder metallurgy is not being used on a significant scale. Until comparatively recently, final drives for ZIL trucks were still being cast from malleable iron instead of being made of steel. Although the Soviets have experimented considerably on the modification of cast iron with magnesium additives, this material, a substitute for cast steel for various engine parts, is still little used at ZIL and GAZ. A particular bottleneck is connecting rod making. Until very recently, 60 per cent of all connecting rods, even at ZIL and GAZ, were finished by hand. (This is apparently traceable to a shortage of sand blasters.) Little press forging equipment is being produced; 2-3000 ton pressure presses are in particularly short supply. The general backwardness of metal-forming operations has resulted in more machining of parts than would otherwise be necessary, large-scale metal waste, excessive weight of components, and relatively low labor productivity.

3. ASSEMBLY AND AUXILIARY OPERATIONS

Assembly is another relatively low priority area. Although the use of conveyors in major plant assembly shops is quite extensive, the proportion of manual labor remains excessive, according to Soviet sources. Lowest priority has been given to auxiliary functions. Materials handling, tool-making, repair, quality control, storage, etc. operate on a technological plane considerably below that of the basic automotive shops. As a result, the number of workers engaged in these activities in the automobile industry clearly exceeds the number of so-called "basic" or "production" workers.

4. AUTOMATION

The Soviets admit to being "well behind the level achieved in the USA" in the field of automation. So far as is known, there are only two fully automated operations in Soviet industry. One is at the First State Bearing Plant in Moscow and the other is the Ulyanovsk Engine Plant which makes pistons for ZIL engines. The former was inspected by Nevin L. Bean of the Ford Motor Co. in late 1955. He was favorably impressed and praised it quite highly. Recent information indicates that in productivity and quality of output it does not compare favorably with the new Bucyrus plant of the Timken Roller Bearing Co. (see AUTOMOTIVE INDUSTRIES, October 1, 1957).

The Ulyanovsk operation has been beset with difficulties. Planning, design, and installation went slowly and were quite expensive (1.7 times the cost of the basic equipment itself). Neither of its two lines (the first installed in 1951, the second in 1954) has yet attained normal operation. Production is uneven, down time is considerable, and cost of production is high. In addition, employment considerably exceeds the projected figure of 93 workers. These problems have been aggravated by inter-ministerial bickering. The Experimental-Research Institute of Metal-Cutting Machine Tools (ENIMS, of the former Ministry of Machine Tool Building), which produced the equipment, accuses the Ulyanovsk plant administration of disinterest, while the latter blames the former for serious technical defects in various components. Both sides have seemed more interested in passing the buck than in making pistons.

In general, automation is being held back in the USSR by the limited scale of industrial specialization and standardization of parts; insufficient scale and continuity of production in many industries; high cost and the lack of a production base for such equipment; and, a vital factor, the lack of an acceptable method of determining the economic feasibility of specific automation projects.

5. CAUSES OF THE PRODUCTION TECHNOLOGY PROBLEM

The primary factors in the present technological situation of the industry appear to be the following:

(a)—Extensive adoption of advanced techniques including automation is limited by the industry's scale of production. This is particularly applicable to the area of metal forming technology. The high levels of capacity utilization essential to economical operation are not attainable at present.

(b)—There is a lack of incentive within the industry for technological progress. This basically stems from the practice of immediately revising a plant's output and cost of production targets following the introduction of new technology. In effect, all those whose income is linked to the plant's level of goal fulfillment are no better off than before the change was made. In fact they sometimes find themselves in a worse position. Under the

ministry, the same percentage of cost reduction was required regardless of the level of plant efficiency. A plant which had already managed to cut production costs to the bone would find itself unable to meet the cost reduction goal for the following period while a less efficiently operated plant would be able to meet the goal with ease. Under such circumstances, it is not surprising that plant directors have frequently opposed rationalizers and inventors, preferring to concentrate upon their immediate production program. Expensive new equipment is frequently left in warehouses for long periods without being used. Special equipment for stamping final drives at ZIL was purchased in 1948 but left in storage for seven years before being put into operation. Similar cases are frequently reported in the Soviet press.

(c)—There is a nation-wide shortage of specialists in the field of advanced production techniques and automation. The engineering staffs which are available at the plants devote relatively little of their time to improving technology, most of it going to current production problems.

(d)—Exchange of information within the industry is inadequate. There is considerable duplication of effort, particularly between ZIL and GAZ. For many years, little use was made of foreign developments. Soviet engineers feared accusations of bowing and scraping before the capitalist West. (This Stalin-period attitude has since been condemned by Khrushchev.)

(e)—For an apparently considerable period, inadequate financing held up progress at ZIL and GAZ. The system of credit extension for specific purposes which was in operation until late 1954 required repayment of loans within a year from funds accumulated through the resultant economy. Plant directors were loath to commit themselves to such terms. (The repayment period has since been extended to from two to three years.)

(f)—"Departmental barriers" have aggravated the general situation. Relations between the automotive and machine-tool industries have apparently become strained over the Ulyanovsk difficulties. Dissimilarity of interests with supplier plants is a source of trouble. An interesting example is the shipment to GAZ during 1956 of 76 types of abrasive polishing wheels which were too large for its tools. Smaller wheels for 160 machines were not received. This is explained by the fact that the production goals of the abrasive manufacturers are expressed in terms of weight. In order to simplify their own tasks, these plants have emphasized production of larger wheels so that a scarcity of the smaller ones has resulted.

D Organization of Labor

Total employment in the automobile plants and allied subsidiary plants has been estimated at roughly 200,000. The extreme paucity of postwar, official, employment data for the various machine building industries of the USSR has necessitated estimation on the basis of scattered information from a multitude of Soviet sources. Accordingly, a high degree of accuracy cannot be claimed for the result.

Industrial wage workers represent about 80 per cent of the industry's total labor force. Engineering and technical personnel comprise 13 per cent; clerical and administrative personnel about three per cent; and apprentices, guards, and "junior service personnel" (messengers, grounds keepers, etc.) comprise the remaining four per cent.

Employment data for individual plants are also quite scarce. The only direct information which has been found consists of reports by American visitors to the ZIL and GAZ establishments. These reports, presumably representing information from plant officials, put the number of workers at GAZ in 1955 at 45,000 and at ZIL in 1954 at 40,000. There is considerable indirect evidence that the GAZ figure is significantly understated, perhaps by as much as 50 per cent.

The organization of the automotive industry, the pressures under which it operates, and the industrial structure of which it is a part have tended in combination to restrict the effectiveness of manpower utilization. The automobile plants manufacture a tremendous assortment of items for their own consumption which, under the circumstances prevailing in the USSR, could be, and in some cases are being, much more cheaply produced by specialized establishments. The constant stress on immediate production has been accompanied by neglect of the technology of such activities as materials handling, storage, and quality control. Those functions (including machine tool setting), which do not directly involve the fabrication of the plant's final commercial product, are termed "auxiliary" in Soviet practice. They are distinct from the "basic" or "production" functions of metal forming, machining, and assembly of commercial products. In the automobile plants, approximately 58 per cent of all industrial wage workers are "auxiliaries" (i.e. are engaged in auxiliary activities) and only 42 per cent perform basic operations.

TABLE VIII

Category of Employment and Occupation	Percentage of Total Labor Force
Total	100
Industrial wage workers	80
Basic workers	34
In metal forming shops	13
In machine shops	12
In assembly shops	8
Auxiliary workers	46
Tool-making and repair	24
Materials handling and storage	9
Quality control	5
Machine-setters	3
Other	5
Engineering-technical personnel	13
Administrative and clerical personnel	3
Other (apprentices, guards, "junior service personnel")	4

DISTRIBUTION OF THE LABOR FORCE OF THE AUTOMOBILE INDUSTRY BY CATEGORY OF EMPLOYMENT AND OCCUPATION

(Partially estimated; all data approximate)

The distribution of the auxiliary workers by occupation is shown in table VIII. Approximately half of them (the tool making and repair workers) are primarily engaged in producing standard measuring and cutting tools (gages, clamps, drills, bits, taps, etc.) and spare parts for the plant's equipment. The production cost of the tools is about four times higher than in the limited number of specialized plants of the tool making industry. The automobile industry is relatively well off in this regard, despite its practice of concentrating its obsolete, low productivity universal machine tools in these auxiliary shops. In other industries, the cost of home-made tools runs five to eight times the specialized plant level. Spare parts production is in a similar state. At ZIL more than half of the repair staff is distributed among the numerous production shops in minuscule groups; spare parts are produced by these groups on a handicraft level with extraordinarily low levels of labor productivity. This decentralization within the plant, which affects other aux-

iliary activities as well, is attributable to the production shop chief's desire to avoid dependence upon the auxiliary shops for these materials. Widespread attempts to achieve such costly self-sufficiency even at the lowest levels of organization through "private" tool making and repair staffs have been subject to recent criticism in the Soviet press.

Intra-plant transport is frequently advanced as the automobile plant's most inefficiently conducted activity. Materials handling equipment in general is in short supply in the USSR. Fork-lift trucks are particularly scarce. (The automobile industry has primary responsibility for their production. It has been accused of deliberate foot-dragging.) Although the automobile plants probably have more conveyor mileage than other industries, nevertheless there are reported to be several thousand workers at ZIL engaged in hand loading, unloading, and similar operations.

The technology of quality control is also on a relatively low level. In 1956 it was reported that only 14 per cent of GAZ' quality control inspectors were using mechanical equipment; the ZIL proportion was only 8 per cent. Simple, rigid, hand tools which can be used by unskilled workers predominate. Sampling control is not widely used. A complete, 100 per cent check is quite common and complete checks of one and the same parameter are sometimes made twice or even three times. As a result it is not uncommon to find that the working time expended in inspecting a part exceeds the time spent in making it by several fold. The quality of the inspection has also frequently been found wanting. Highly repetitive, dull techniques have caused boredom, fatigue, and slipshod work. Some of the shortcomings of Soviet vehicles have been traced to this factor.

Machine-setters are classified as "auxiliary" because they adjust the machine but do not operate it. A major campaign to reduce the number of machine-setters by teaching the machinists to adjust their own equipment has apparently been quite successful. A principal benefit has been reduction of down time.

Overall, it is apparent that the technology of the automobile industry's auxiliary operations is much behind that of basic productions. The proportion of manual labor is higher, its machine tool park is older, and in other ways it has been long neglected. A sizable waste of manpower has resulted. Major inroads upon the problem require the development of large-scale, specialized production of equipment which would increase the efficiency of some of the auxiliary operations and completely dispense with others. This, in turn, would seem to await a stronger orientation toward maximizing the ratio of output to labor input rather than output to capital as appears to be the case today.

V
The Outlook for the Soviet Automobile Industry

THE prospects of the Soviet automotive industry for the next few years appear to hinge upon two basic factors of national scope. These are the availability of capital for civilian heavy industry and the degree to which the industrial *modus operandi* can be improved.

As to the first, the automotive industry's situation does not appear to be favorable. Well before the official announcement of the scrapping of the Sixth Five-Year Plan, this industry was put on notice that the funds available to it for investment in new equipment were to be curtailed. It was told that limited availability of new equipment meant primary emphasis upon modernization of present facilities and that the industry would have to continue relying upon its own tool shops for a large part of its requirements. Prospects in this direction therefore do not appear promising.

The opportunities for improvement in the organization and operation of the industry, on the other hand, are considerable. The ministerial system of control over most civilian industries (including the automotive) was recently abandoned in favor of a decentralized system of regional economic control. Although it is much too early for an evaluation of the new order, certain aspects of the transition are becoming apparent. From the point of view of the individual plant, the area of mechanical planning from above is to be sharply reduced. The authority and responsibility of the plant director, especially in the distribution of rewards, is to be increased. This will probably result in improvement of the incentive system, in increased orientation toward qualitative rather than quantitative performance. Greater utilization of locally available resources and improved relations with supplier plants now subordinate to the same regional economic council can also be anticipated. It therefore appears that decentralization of control bodes well for the automotive industry.

The degree of improvement which can be realized is not without limit, however. A tendency toward replacement of "departmentalism" (under which each ministry confined its interests to its own problems largely at the expense of the consumer) by geographical "localism" has already developed. This is basically a function of another factor which will remain under the new system and which is a fundamental determinant of the present situation. This is that demand for virtually all producers' and consumers' goods in the USSR exceeds supply. Here is basically a seller's market and Soviet industry has long been capitalizing on this condition. Economic regionalization contains no apparent mechanism for altering this. Furthermore, the economy of the USSR remains planned. The area of local responsibility has been increased, but centralized overall control by the State Planning Committee (Gosplan) continues.

Under the ministerial system, form often prevailed over substance. Whether this can be changed under the regional economic councils or any other form of national economic planning are questions which can only be the subject of speculation.

SUMMARY

In sum, the fate of the Soviet automotive industry is inextricably entwined with broader issues of economic and political organization. This industry is but one part of a national complex, and its development and progress are largely dependent upon development and progress in numerous other areas. The quality of the Soviet Union's roads, the development of the petroleum refining industry, the quality and quantity of raw materials available to the automotive industry, and the size, skills, and motivation of its labor force are but a few of the factors involved. All are vital to the future of the Soviet automotive industry and all involve decisions of basic national policy.

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London Representative of AUTOMOTIVE INDUSTRIES Evaluates Operations and Equipment at ZIL and Moskvich Plants; Summarizes Features of Major Russian Vehicles

PART I

FIRST-HAND REPORT ON RUSSIA'S MOTOR VEHICLE INDUSTRY

General Observations ZIL Plant in Moscow

By
David Scott

RECENT visits to two of Russia's largest vehicle factories indicated that Soviet motor industry is employing manufacturing methods up to average West European standards. They disclosed, however, few outstanding examples of production techniques such as those used in the manufacture of machine tools, ball bearings or electric motors—where Russia is rivaling even America.

This relative lag in development results from the system of state-controlled priorities and planning, which has emphasized trucks at the expense of passenger cars, and established production figures for both on the basis of the country's economic and military needs rather than on consumer demand.

Current output of trucks is at an annual rate of 370,000 (estimated from official figures for the first six months of 1957), and a very high proportion has a payload rating of $2\frac{1}{2}$ tons and over. While this is only about half the American production in the same load category, it is over three times the combined output of Britain, West Germany and France.

Yet manufacture in even this quantity is simplified by the limited variety of basic models turned out—perhaps two dozen, of which only a few are truly mass-produced. Passenger cars are being made at an annual rate of only 110,000, and are confined to three "popular" types and a trickle of limousines for Soviet officialdom. The standardization of designs, together with uncomplicated constructions and complete uniformity of color in the case of trucks, are apparently not felt to justify spectacular manufacturing techniques nor to demand any complex system of programming for assembly.

Component Manufacture

Other generalizations are possible from first-hand observations.

DAVID SCOTT, author of this series of three articles, is British Correspondent for AUTOMOTIVE INDUSTRIES and an eminent writer in the technical fields. He wrote the articles following a trip during the latter half of September, 1957 to Moscow. There he made inspections of two of Russia's largest automotive factories, and examined latest Soviet vehicles on display at the Moscow permanent industrial exposition. Information was gathered and compiled by Mr. Scott, and he also personally took all the pictures. The resultant facts, as presented, were checked with and confirmed by British automotive engineers who had visited the same plants.

A very high proportion of vehicle components are made locally at the plants—up to 65 per cent in some cases—including all forgings, castings and stampings and even parts like piston rings. This is apparently dictated by the relatively few specialist factories for items other than bearings, rubber, glass and electrical equipment, and the fact that vehicle production is concentrated in only a handful of large enterprises. In addition, the vast distances within the USSR, whose area is nearly three times that of the United States, present a major supply problem in the absence of an adequate transport system.

It is expected that the more recent policy of industrial decentralization will improve interfactory cooperation and reduce uneconomic self-sufficiency. But the abolition of the Ministry of Automobile Production and the transfer of planning and administrative powers to regional authorities took place only in July, and it was stated that it was still too early to realize many benefits.

Production Tools

Tooling in the plants visited is in general fairly modern, and practically all of the machines are Russian. Most of the equipment was produced in the Soviets' highly-developed machine tool industry; although a number of the special-purpose machines, such as rotary automatics, were made in the plants which used them. There was also a sprinkling of Czechoslovak and East German units, and a few old American ones. These last were mostly forging and stamping presses, a sector where the Soviet industry is still backward.

Women are employed not only in very large numbers, but on virtually every type of man's job, including the heaviest and roughest work. After a few days in Moscow one becomes accustomed to seeing women on road gangs and as bricklayers high on the scaffolding of new buildings; but at the factories it was still a surprise to find them alongside men in the foundry or forging shop.

ZIL Plant

The ZIL plant in Moscow is the oldest and second largest of its kind in the country (the biggest being at Gorkiy), and has some 60 shops spread over a 500-acre site. The payroll totals 40,000, nearly a third being women. The designation ZIL stands for "Factory named after Likhachjov," who was the director there for 25 years

The writer was received at the ZIL plant by senior staff members. Seated around the desk (left to right) are: A. G. Zarubin, deputy chief designer; S. S. Saveliev, deputy chief engineer; and I. I. Karzov, deputy director.

Engine assembly line has a knee-high track with pallets moved by drag chain. Return conveyor is underneath. Output is 400 engines a day, plus replacement units.

and a government Minister until his death in 1956. Prior to that time it was "named after Stalin."

This plant produced its first car in 1924, when total output was 10 units. It has since been greatly expanded and modernized three times. As a matter of interest, in the late autumn of 1941 when the German army had driven to within a few miles of Moscow, the entire factory with all its equipment and workers, was evacuated some 1000 miles eastward to beyond the Ural Mountains, where production was re-started. The move is reported to have taken only two weeks. Early in 1942, after the successful counter-offensive, the plant was returned to its present location.

Output

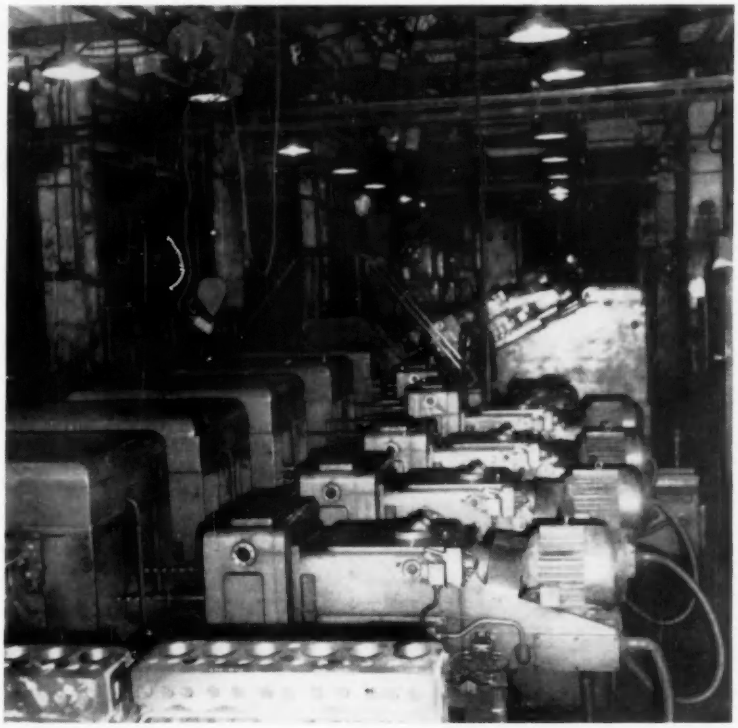
Current annual output is 120,000 trucks and 3500 buses, together with large quantities of spare parts to maintain the million-odd identical vehicles that have been in use for many years. As a side line, 460,000 bicycles and 85,000 refrigerators are also made per year. ZIL works two shifts (the unusual hours of 8 am to 5 pm and 8 pm to 5 am), and on the basis of a 300-day year turns out 400 trucks a day, or one every 2½ minutes.

Basic truck model is the ZIL-150, introduced in 1948. It is a two-axle four-tonner, with a six-cylinder 338-cu in. gasoline engine developing 95 hp at 2700 rpm. The low quality of the ordinary Russian fuel (about 65 octane) is reflected in the side-valve design and 6 to 1 compression ratio of the power unit. The same engine is used in the ZIL-151, a six-by-six version rated at 4½ tons.

It was stated, however, that these rated payloads were merely nominal, and that the vehicles would have a considerably higher rating in western Europe. Some confirmation of this claim can be made by the writer, who drove from London to Moscow in a GM-built Vauxhall Victor. These trucks, and the smaller 2½-tonners made in Gorkiy, are clearly the backbone of Russian transport, and thousands of them can be seen along the 635-mile route from the border. They are grossly overloaded and literally driven into the ground on the torturous back roads. Yet truck drivers questioned at gas stations reported that they normally did 120,000 miles before a major overhaul, and had an average life of 500,000 miles.

Machine Tools

ZIL designs and makes almost all of its specialized machines on the spot, and has four large toolrooms employing 3500 people. One of the more advanced units seen under construction was a two-spindle spiral bevel gear generator that simultaneously cuts the ring gear and pinion for a front-wheel drive axle. Several of these machines had already been completed



First of a sequence of five automatic transfer lines for cylinder blocks. This has 16 work stations, with double positions at the first eight where two heads are paired on a common slide. Cylinder head and pan faces are previously machined on a drum type miller.

and were being installed on the floor.

Another automatic was a three-station rotary indexing machine for drilling and boring the block of a six-way air valve. Parenthetically, this component was for a new three-axle truck that incorporates a system for deflating and inflating the tires through the wheel spindles, in order to improve traction while running on ice or mud. The machine was built from standard heads and tables that are combined to form multi-station units for a wide variety of small components.

Most of the actual tools are also made locally. This includes even round and flat broaches, milled from solid bars. Hobs for gear cutting are produced and assembled in sections, between which the bits are clamped.

Conveyor Systems

Work handling is largely mechanized in the several foundries, where there are altogether some 10 miles of conveyors. Among these are overhead monorails for cooling and transporting castings; enclosed belts carrying sand from a central hopper to the individual jolt-molding machines through gravity chutes; floor-level conveyors; and trolleys moved by drag-chain.

About 400 tons of iron are cast daily, and typical of the mechanized setup is that for brake drums. Molten metal is carried from the furnace by ladles on a monorail which runs directly above one side of the mold box conveyor loop. Workers, standing on an adjacent moving belt, guide and tilt each ladle to fill successive molds, after which the empty ladle is returned to the furnace. Molds on the loop then enter the cooling tunnel. The area is well ventilated with fans and exhaust ducts at each pouring station.

In another section, molds for piston rings are prepared on a line of 12 jolt machines, all with women operators. Sand is gravity-fed to each machine which forms the flat pancake sections having

ZIL-150, dating from 1948, has a four-ton payload rating, and is powered by a 338-cu in., six-cylinder engine that develops 95 hp at 2700 rpm. Current production of this and the three-axle ZIL-151 is 400 per two-shift day, plus spare parts for the thousands of identical vehicles already in use.

cavities for six rings disposed around the central sprue hole. The sections are placed manually on trolleys that run in a train past the line of machines. Completed stacks of 18 sections (each providing 102 rings) are then conveyed to the nearby casting shop.

Automatic Loading

Many pre-war American machines were seen in the forging shops, but a number of these incorporated systems for automatic loading and unloading made at ZIL. For example, an old National Maxipress, tooled to die-forge ball joints, is supplied with hot blanks directly from an induction heating unit. Cold blanks in a hopper on top of the heating unit are fed continuously into the coil, then ejected into a gravity chute leading to the die.

A comparable setup is used for forging valve tappets in a horizontal two-stage hot-forming machine made at the factory. Cylindrical blanks from a simple hopper are gravity-fed into an induction loop facing the first fixed die. The closing die carried on a mechanical ram pushes the hot blank home, after which the work is automatically extracted and transferred to the second die for the final operation. Output is about 600 tappets an hour.

Long gas-fired furnaces with chain transport are used for heating larger forging blanks such as I-beam axles and crankshafts, and these are usually linked by roller or track conveyor to the presses. Aside from the effective use made of old machines, one was struck by the pace of the workers, and by the number of women on these heavy jobs.

There is considerable mechanization in the foundry. This line for casting brake drums includes ladles carried on an overhead monorail, and pouring positions on a belt moving in step with the continuous loop of molds. The ventilation fan and exhaust ducts are common provisions.

Machining

Highlights of the machining were the 20 automatic transfer lines used for transmission and clutch housings, and cylinder blocks and heads. The machines, made mostly at the Krasnoii Proletarii factory in Moscow, are built with standard unit heads of only a few basic types. Center bed sections, with hydraulic transfer mechanism and upward work clamping, are also standardized. As with many Soviet machines turned out in large quantities for domestic use, this equipment showed minimum attention to external finish. Functional designs and rugged construction weigh more heavily than aesthetic or competitive appearance.

Cylinder blocks are machined on

a sequence of five lines, the first of which exemplifies the entire transfer installation. This has a total of 16 work stations with 26 individual heads and a total of 80 spindles for drilling, boring and tapping. Following facing on large drum millers, blocks enter the line sideways and initially index through the first four double stations, where two multi-spindle heads, paired on common slides on each side of the bed, machine the two ends. After the single ninth station (tapping), the block is turned through 90 deg and passes end-on through the remainder of the line which has inclined, horizontal and vertical single heads. Swarf is carried out on an underbed belt.

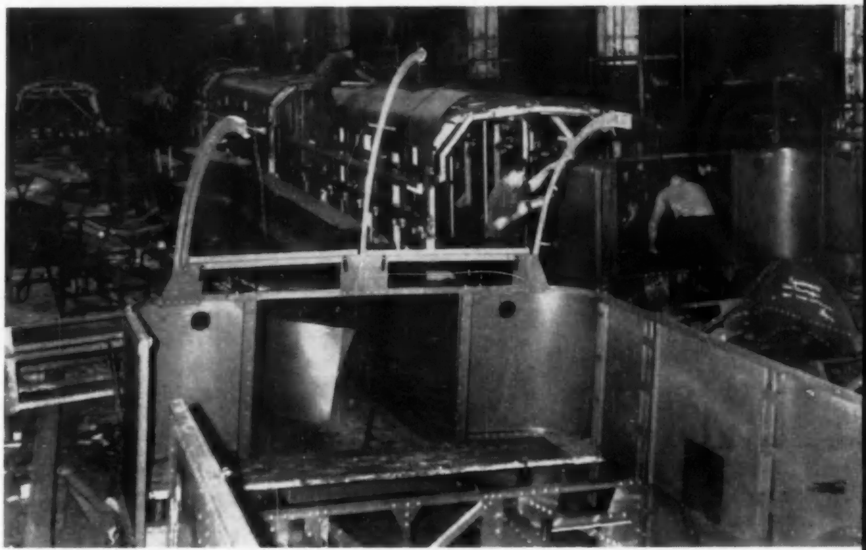
Assembly Operations

Engine assembly is conveyorized in an orthodox manner, and considerable use is made of power tools suspended above each station. Components and sub-assemblies flow in at right angles. There are two final truck-assembly lines, separate ones being used for the two- and three-axle models. Subassembled chassis start out on the link conveyor in an inverted position, when springs and axles are added. They are then reversed by a large turn-over fixture for subsequent installation of the engine, transmission, and finally the cab. Drop-sided and dump bodies are fitted in another bay, after chassis inspection and testing.

The ZIL-150 is now being made under license in China in a new Soviet-equipped factory there. It was learned that a cadre of 800 Chinese engineers spent six months at the Moscow plant for training.

Bus Manufacture

Manufacture of buses at ZIL is on a much smaller scale, amounting to some 12 a day of three different types. Two of these are the ZIL-155 and ZIL-158 for urban transport, seating 28 and 36 passengers respectively and both powered by the truck engine. The third is the ZIL-127, a long-distance coach with a rear-mounted 180-hp supercharged Diesel. It has an integral chassis-body made entirely of aluminum alloy. Panels and supporting members of the superstructure are mainly riveted, but frame sections and other parts exposed to damage from collisions are assembled by bolts to facilitate repairs.



Bus bodies are made entirely from aluminum alloy. Panels are mainly riveted, but some frame sections and other parts exposed to damage from collisions are assembled by bolts to simplify repairs when a damaged member needs replacement. Body and frame are integral.

BEGIN PART II ▸▸

PART II

FIRST-HAND REPORT ON RUSSIA'S MOTOR VEHICLE INDUSTRY

Moskvich Plant in Moscow

By
David Scott

THE Moskvich car is made in a factory with the formidable name of Moskovskii Zavod Malolitrazshnikh Avtomobilei, which translates as "the Moscow plant for automobiles of small displacement." Current daily output is 185; and full capacity is seen at about 220 a day, which is expected to be reached during 1958. The Soviet Union's entire annual production of 110,000 passenger cars is shared evenly between this and the Molotov plant in Gorkiy that makes the Pobieda and Volga.

Considerably smaller, but more modern than ZIL, MZMA was built in 1932 for assembling trucks and tractors. Car manufacture was introduced in 1938; and during the war the plant turned out military equipment. In 1947, after repair of minor bomb damage, it started production of a copy of the pre-war Opel Cadet. Body tooling and dies for this model were obtained from Germany as reparations, it was stated, but no presses or other machines.

The 22-hp Moskvich was continued for 10 years, and was stopped only last May when output of the present newer model (bearing the same name) had grown to 165 a day. This practice of continuity during a model changeover is apparently general in Russia. The new car retains the four-cylinder side-valve engine, but with displacement increased to 74.6 cu in. and power increased to 35 hp at 4200 rpm.

MZMA employs 10,000 workers on two shifts, of whom 35 per cent are women. Pay is equal for both sexes, and is on piece rates for most jobs. It was reported that average wages were about 950 rubles a month—the equivalent of $95 at the fairly realistic exchange rate for tourists—though some earnings might run up to $200 or even $300. The Moskvich car retails for $1500, and some 500 of the factory workers were said to each own one. There is no consumer credit in Russia.

The top engineering staff who received the writer seemed familiar with western production methods, although this knowledge was derived more from technical journals than from personal experience. AUTOMOTIVE INDUSTRIES is well-known, despite the fact that it apparently reaches Russia only in limited numbers. The shortage is overcome by duplication, and each issue is faithfully

Engineers at MZMA took a great interest in the GM-built Vauxhall Victor driven by the writer from London. The three at the left are: I. T. Fedorovitch, deputy technologist; I. N. Matvejev, assistant chief engineer; and L. M. Zelenov, deputy chief designer.

reproduced in full color, including all the advertisements. A copy seen at the factory could be distinguished from the original only by the heavy paper and greater thickness.

Axle Shaft Forming

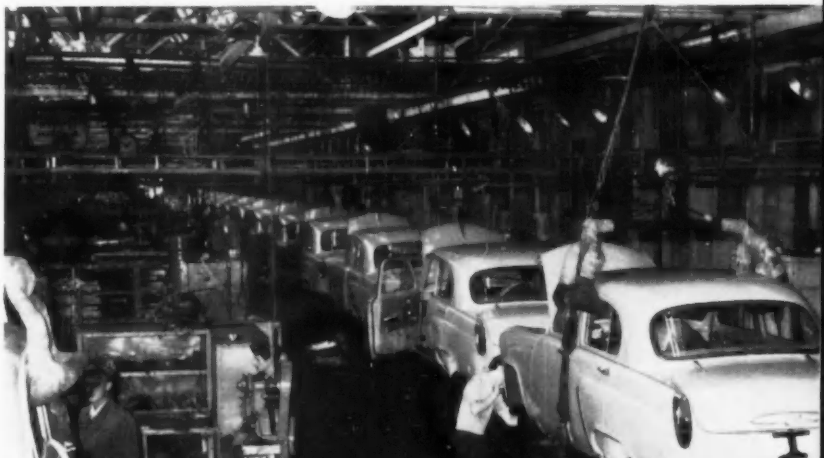
Singled out as one of the highlights in the forging shop was a locally-built hot-rolling machine for drawing and forming axle shafts. Stock is two inch round bars precut to 36 in. long and stored in a loading hopper at floor level. The automatic cycle starts with a chain elevator raising the bars singly to the top and rear of the machine, where they are pushed by a pneumatic ram through the full-length coil of an induction heating unit.

After emerging from the coil, the hot bar rolls forward down inclined rails and falls to rest on V-blocks on the input side of the rolling station. With the die formed by three power-driven rolls fully extended, a mechanical chuck on an air ram approaches from the other side, passes through the opening, and grips the end of the bar. It draws the bar into the die opening, when the three rolls on individual radial slides are closed in against the work by hydraulic rams.

The rolls are then rotated by separate jointed and splined shafts, while the bar is turned by the chuck at the same speed. As the chuck on its ram draws the bar through the die, the radial positions of the three rolls are simultaneously varied by a hydraulic copying mechanism on the front of the machine. This template, with a tracer following the movement of the bar, determines the bar's profile. After the complete passage, the chuck releases the bar, which rolls down gravity rails in the cooling area. The final bar of reduced diameter and extended length is cut in half to form a pair of axle shafts, which are subsequently machined.

Valve Forging

An example of an automated setup applied to an old American crank press was one for forging



Body-drop station near the center of the Moskvich final assembly line. Finished bodies come in from the left on a slat conveyor, and are carried across by a hoist on an overhead monorail. Current daily output is 185 cars.

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—David Scott

valves. Precut blanks in a hopper on top of an induction heating unit are dropped into the high-frequency coil, from which they are ejected singly into a gravity chute. This carries them into the first lower die of the press, which has been modified for two-stage stamping. After the initial forming, an air-operated transfer arm extracts the work from the first die and deposits it in the second one during the ram upstroke. At the same time it withdraws the completed forging from the second die and drops it into a quenching bath. Cooled valves are removed from the tank by a small elevator conveyor. Built at the factory, this installation has an output of 500 pieces an hour.

Work Transfer

MZMA appeared to use more automatic transfer lines for small components than the ZIL plant. A number of platen-type machines are employed, one of the largest being a 14-station line for transmission extension housings. Operations on the aluminum casting cover drilling, tapping, finish-boring, and milling on the two end faces and top.

There is a total of 40 platens with hydraulic clamping to the rails. A fast-return conveyor under the center bed carries platens with completed work back to the load-unload station at the head of the line. As each platen reaches the end of the line and is lowered by a hydraulic platform to the pick-up point of the underbed conveyor, it is simultaneously turned through 90 deg to permit end-on passage of the elongated casting through the narrow tunnel.

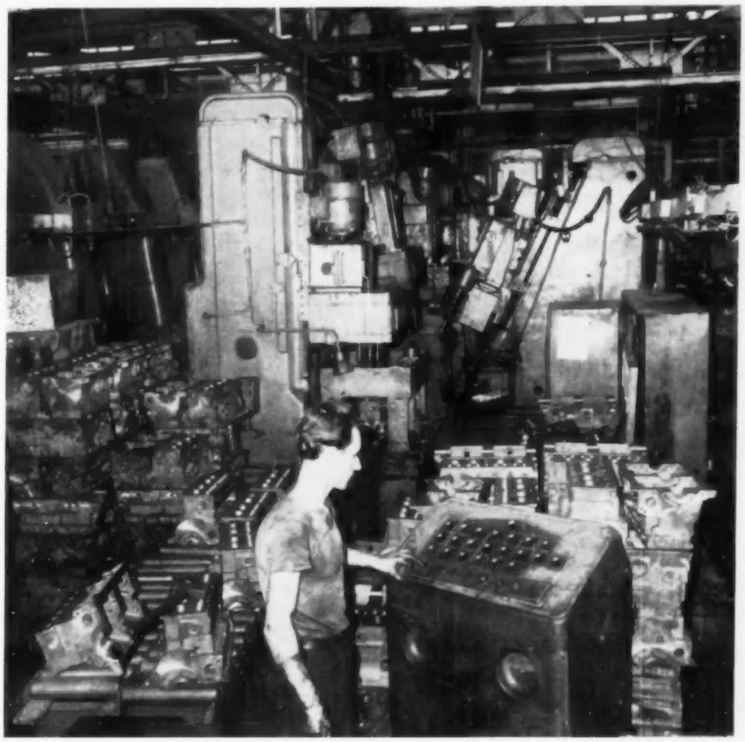
Swarf is removed continuously by a worm terminating in a small elevator conveyor that deposits the scrap in a bin. Each spindle head has a hinged semi-circular chip guard that shrouds the work area during machining. When the slide retracts the guard is automatically raised clear to allow transfer.

Manifold Machining

Exhaust manifolds are machined on a platen-type transfer line that is doubled back on itself in U-form in order to save floor space. At the end of the outward section of track, the loaded platens are shuttled sideways by a hydraulic pusher to the start of the inward section. Both sides, as well as the top of the work, are thus presented to the tools ranged along the outside of the U. Loading and unloading is at the same

Moskvich sedan, introduced in 1956, has a 74.6 cu in. side-valve engine with 7 to 1 compression ratio that develops 35 hp at 4200 rpm

station, and no return conveyor is needed. Twenty platens are used on this six-station machine that drills, bores, taps and mills. There is a duplicate line for intake manifolds.



First of three 12-station transfer lines for cylinder blocks. Operations include drilling, boring and tapping.

Cylinder Blocks

Cylinder blocks are drilled, bored and tapped on a series of three 12-station transfer machines linked by roller track. These are of similar construction to the large lines at the ZIL plant, and are apparently of standard Russian design. Also following Soviet practice is the previous milling of head and pan faces on a big drum-type machine.

Main bearing cap holes are drilled and tapped on a factory-built rotary indexing machine having two work stations. A single vertical slide carries the common multi-spindle head that spans both stations. There are also two horizontal heads that drill and tap the manifold mounting holes. Inverted cylinder blocks from the roller track are raised by a hydraulic lifting section to the level of the loading station of the triangular table.

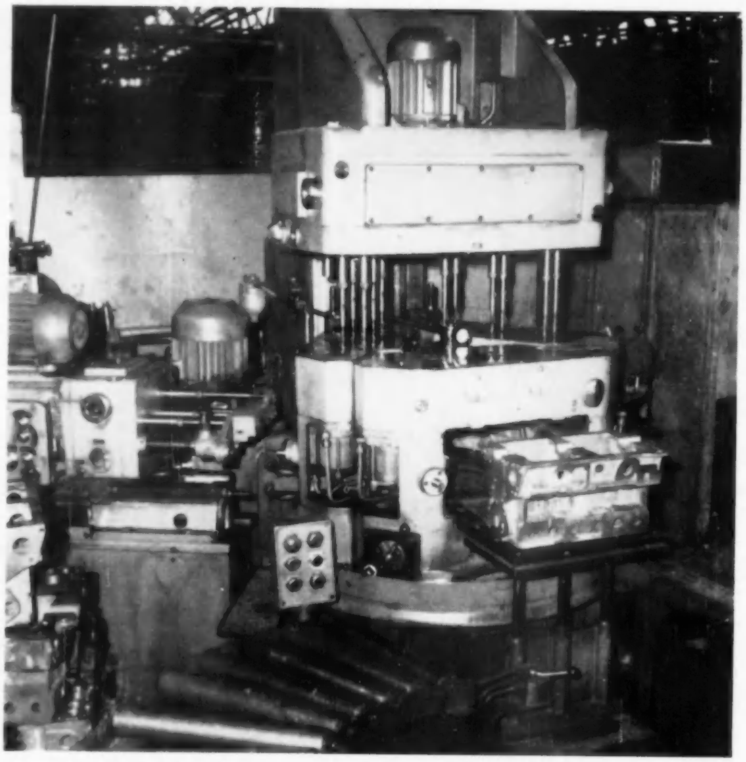
Pistons

Many rotary automatics are used for small components, and it was stated that most of them were made at the factory. Their resemblance to those produced at ZIL suggested a common or standard design made available to different toolrooms on a do-it-yourself basis. One of these was a five-station machine for drilling and slitting piston skirts. Pistons with pins fitted are placed vertically onto a forked spindle at the loading station. Downward clamping is automatic as the circular table indexes forward, and so is rotation of the spindle through 180 deg after the third station to present the opposite side of the piston for machining.

Moskvich station wagon has the rear sheet metal welded onto the standard sedan body.

Car Assembly

The final assembly line for the Moskvich consists of a waist-high track with pairs of fixtures for the rear axle and front suspension. Finished body shells move in on a slat conveyor parallel to the main line. They are carried across and dropped onto the suspension attachment points by an electric hoist on an overhead monorail. The Moskvich is of integral body and frame construction. (*Continued on next page*)



After leaving the transfer lines, cylinder blocks are completed on a number of rotary indexing machines linked by roller track. This two-station unit drills and taps the bearing cap and manifold holes. Hydraulic lift in the foreground raises work to the loading position.

In addition to the standard sedan, a few station wagons and special four-wheel drive versions with high springing are turned out each day.

Although production at MZMA falls far short of satisfying the home demand, and there is a waiting period of up to two years for a new Moskvitch, these cars are now being exported even to non-Communist countries. On the factory grounds there was a long line of crated cars stenciled for shipment to Argentina.

Plant Entrée

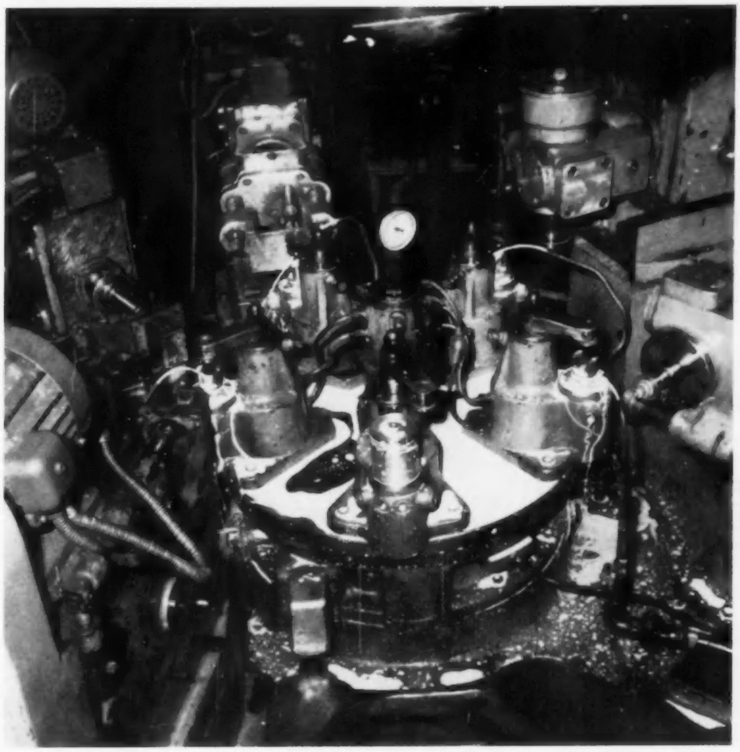
The vists to this and the ZIL plant had to be previously arranged through the Moscow City Council, which has jurisdiction over such matters since the abolition of the government ministry during July, 1957. But the more recent decentralization policy, which gives more autonomy to individual industrial units, has brought an atmosphere of comparative relaxation at these places.

The actual entry into both Russian factories was much simpler and more informal than similar visits made by the writer in Czechoslovakia and Poland. No special pass was needed, there was no waste of time in the guard room while credentials were checked, and the camera was not challenged. One merely drove through the gate and walked straight up to the head office.

Once approval in principle had been granted by a higher author-

Platen-type transfer line with 14 stations drills, taps, finish-bores and mills aluminum castings for transmission extension housings. Visible in the picture are the automatic chip guards in raised positions, under-bed return conveyor with lowering platform (bottom right), and swarf disposal elevator at the end of the worm conveyor (bottom left).

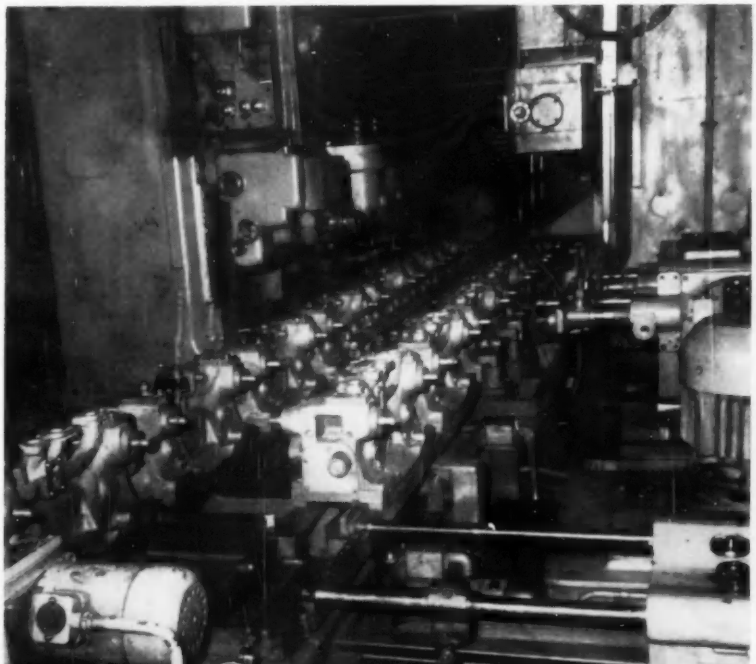
ity, it was apparently up to the local management to determine what one could see and whether photographs could be taken. While we obviously did not see the entire plant for commercial and probably security reasons, as well as because of the time factor, a selection of production highlights was revealed, and photography was permitted except in a few cases. These were of an untidy area of the floor, of women on extremely heavy work in the foundry, and of one or two prototype cars openly parked on the factory roads.



Typical of the many factory-built rotary automatics in use is this five-station machine for drilling and slitting piston skirts. Pistons carried on forked spindles are turned through 180 deg after the third station. Piston rings are cast in the plant's foundry.

Part III of this David Scott article, which is devoted to Soviet engines and vehicles, starts on the following page.

In it the author describes some of the new developments in the Russian motor vehicle industry which—in general—tends to lag far behind that of the U. S. and most European countries



Transfer line for manifolds is doubled back on itself to save space and eliminate the need for a return conveyor. Hydraulic pusher at the midway point (foreground) shuttles the pallets across to the start of the inward section of track. There are six work stations that drill, bore, tap and mill.

PART III

FIRST-HAND REPORT ON RUSSIA'S MOTOR VEHICLE INDUSTRY

Latest Engines *and* Motor Vehicles

By
David Scott

RUSSIAN designs have until now tended to lag far behind the West. Since its inception in 1924, the Soviet motor industry has concentrated on making utilitarian vehicles in the greatest numbers possible in order to meet the basic needs of road transport in a large, underdeveloped country. Mass production was made easier by strictly limiting variety to a few standard types; and by using simple constructions that went unaltered, even without a face-lift, for many years after the initial tooling was fixed.

There was no stimulus of competition to modernize styling and to introduce technical advances. American cars, trucks and tractors have often been copied (starting in 1932 with the Model "A" Ford made in Gorkiy), but these designs were adopted and frozen usually after their eclipse in the U. S. In addition, the poor quality of local gasoline (66-octane is general) dictated the continuance of side-valve engines with low compression ratios.

New V-8 Engines

A modest shift away from this pattern of rigidity and backwardness now is apparently under way. During this visit to Russia the writer was able to see some of the latest production and prototype vehicles at the permanent Agricultural and Industrial Exhibition in Moscow. What are believed to be the Soviet Union's first V-8 gasoline engines were on show there. One of these, with 364.78 cu in. displacement, develops 200 hp at 4000 rpm, and has a maximum torque of 318 lb-ft at 2800 rpm. Bore is 3.93 in., stroke 3.74 in., and total weight 840 lb. Overhead valves, V-design, and an 8.25 to 1 compression ratio suggest the future availability of higher-octane gasoline.

This unit will power the new ZIL-111 seven passenger limousine scheduled to replace the existing Packard-like ZIL-110. While this car has not yet been publicly exhibited, it is understood to have an automatic transmission (described as "Hydromatic"), hypoid final drive, and roughly the same dimensions as the model it replaces. Body styling is not yet finalized, and it is not known when production will start. The engine will also be used in a new five-ton truck, designated ZIL-130.

Another V-8 on display is in-

Prototype of the ZIL-111 seven-passenger limousine which is powered by one of Russia's first V-8 engines

tended for the forthcoming ZIL-129 bus. Although it has overhead valves and a greater displacement (424.5 cu in.), compression ratio is only 6.5 to 1, and rated output 180 hp at 3200 rpm. Weight is 990 lb. Of considerably over-square design, it has a 4.25-in. bore and 3.74-in stroke (having the same crankshaft and presumably other parts in common with the smaller-bore unit).

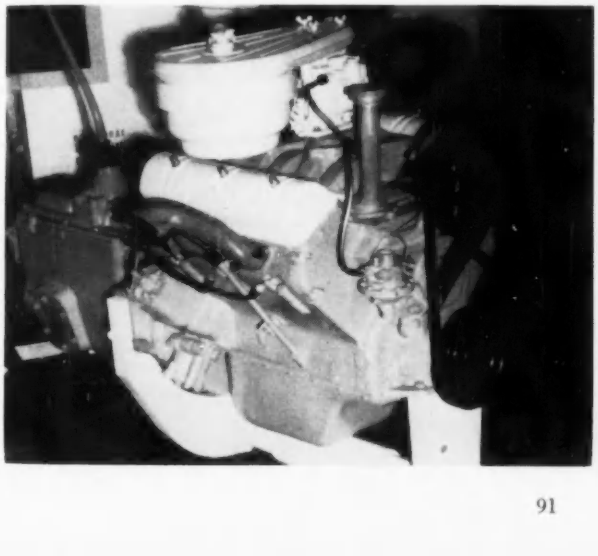
Also on view was a V-6 version of this latter engine, having the same bore and stroke. With a displacement of 317.2 cu in., output is 135 hp at 3200 rpm. It weighs 740 lb and is destined for another new bus.

Automobiles

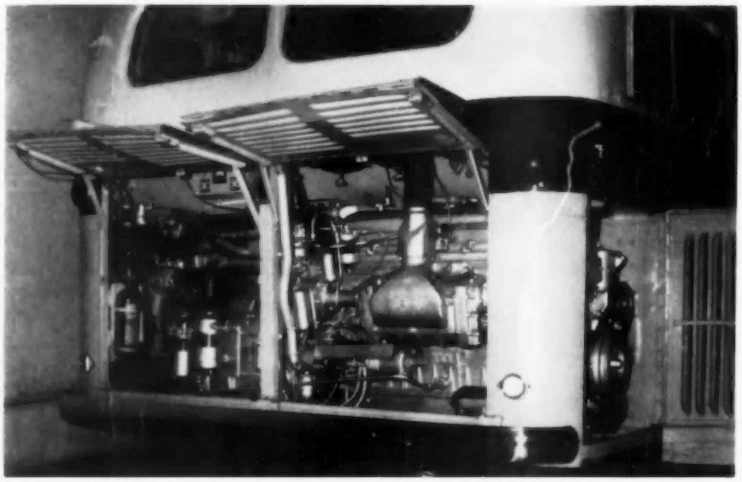
While no entirely-new cars were exhibited, it was learned that the Volga will soon be fitted with a 149-cu in. overhead-valve engine of 70 hp at 3400 rpm, replacing the present L-head unit. In addition, a similar 45-hp unit is planned for the Moskvitch. This small car was displayed in the form of a station wagon, having a rear box section with a single side-hinged door welded onto the standard four-door sedan body. Experiments are now being con-

This V-8 engine, intended for the ZIL-111 car and a new five-ton truck, has 364.78-cu in. displacement and develops 200 hp at 4000 rpm

With a displacement of 317.2 cu in. this V-6 engine has an output of 135 hp at 3200 rpm



Integrally-constructed LAZ-695B has a frame extension at the rear to carry the engine. Powerplant will be the new V-6 when it is available.



Rear-mounted engine of the ZIL-127 intercity bus is a six-cylinder two-stroke supercharged Diesel of 426-cu in. displacement, developing 180 hp at 2000 rpm. Radiator is at the extreme left, and the fan is belt-driven through a jointed and splined shaft.

ducted to make this added portion out of plastic.

An unusual variation on the Moskvich was a cross-country version with four-wheel drive, designated M-410. The rear axle and differential are duplicated in front, and individual highly-arched leaf springs raise the entire body by five inches. Approach and departure angles are thereby increased to 43 deg and 27.5 deg. Ground clearance is raised to nearly nine inches with 6.40-15 tires instead of the standard 5.60-in. section. The transmission has a two-speed transfer case supplementing the conventional three-speed gearbox, giving a total of six forward and two reverse ratios.

Like the standard Moskvich, the M-410 has a number of features that make it adaptable to the rigors of Russian roads, weather and general driving conditions. Towing hooks, a radiator shutter, and coarse and fine oil filters are standard equipment, as are the heater and radio, and collapsible seats that drop flat to form a bed. The four-cylinder engine, with replaceable cylinder liners and 74-cu in. displacement, puts out 35 hp at 4200 rpm.

Motor Trucks

One of the new trucks from the Molotov plant in Gorkiy was the GAZ-56. Notable for its payload rating of only 1½ tons in a country where heavy vehicles are the rule, it is powered by the 70-hp overhead - valve engine planned for the Volga car. An unusual feature is that the brake drums are completely enclosed and sealed against entry of water, dust and dirt.

Another pre-production machine from the same factory, the GAZ-62, exemplifies the way the Russian industry combines major components from existing models. This one - tonner, resembling America's wartime weapons-carrier, uses the chassis of the GAZ-56, the front-drive axle from the cross-country GAZ-69, and the engine from the GAZ-51 2½-ton truck. The basic six-cylinder 212-cu in. engine has an improved cylinder head and other changes that

raise output to 76 hp at 3400 rpm.

Motor Buses

Most interesting of the buses on display was the ZIL-127 intercity coach. Its integral body-frame unit is made entirely of aluminum alloy, with a tubular extension at the rear to form the engine compartment. The six-cylinder Diesel, of 426 cu in. displacement, is a two-stroke type with twin overhead exhaust valves for each cylinder and inlet ports in the cylinder liner. Combustion chambers are recessed in the piston crowns. Supercharged by a Roots-type blower, it develops 180 hp at 2000 rpm. Drive is through a five-speed transmission.

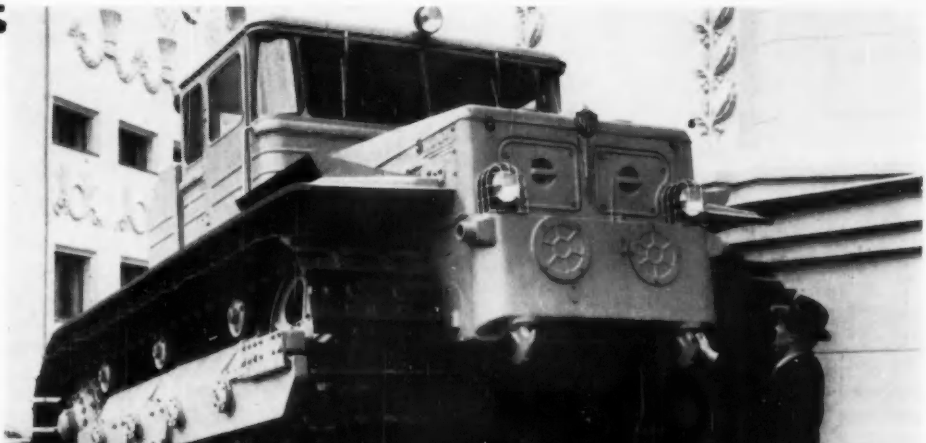
The engine and transmission are mounted on a triangular frame whose base pivots on the forward wall of the compartment, and whose apex is supported by a horizontal tubular member at the top rear through a carrier bar and rubber blocks under compression. The cooling radiator is in the left wall of the compartment, and the fan is belt-driven by a shaft that is jointed and splined to allow for engine movement as well as belt adjustment.

Accommodation is for 32 passengers in reclining seats, and among the interior appointments are blue nightlights along the sunken center aisle. The ZIL-127 is stated to have a maximum speed of 72 mph, and during the 635-mile drive through Russia to Moscow the writer saw a number of these coaches cruising at close to that figure. Unladen weight is 20,800 lb, overall length 32.5 ft, and wheelbase 18 ft 4 in.

The PAZ-652 city bus, made at the Pavlovsky factory near Gorkiy, has full-forward control, and features interior heating by hot air. The cooling radiator is placed at the right of the centrally-mounted engine, and takes in fresh air through a facing grille in the front body panel. The fan forces warm air into a receiving duct that narrows to a thin rectangular section as it swings across the body, where it also forms a low partition behind the engine and driver's seat. The duct then reduces further to a small square section when it runs along the left edge of the floor, opposite the doors, with an outlet at each row of seats. In warm weather a damper valve closes the throat of the duct and the fan exhausts through a grille in the right outer panel. Seating 22 passengers, this two-door model is powered by the same engine as the ZIM car—a six-cylinder unit rated 90 hp at 3600 rpm.

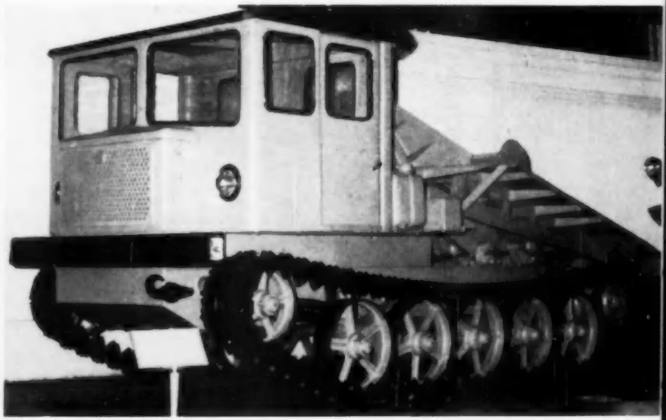
Designed for longer distances, the LAZ-695B, made in Lvov, is of semi-integral construction, hav-

GAZ-56, rated at 1½ tons, has fully-enclosed brake drums



Russia's largest crawler tractor, the Diesel-electric DET-250, has a maximum drawbar pull of 23 tons. It is powered by a 1708-cu-in. V-12 engine rated 300 hp at 1500 rpm.

Fifteen-ton crawler, powered by a 140-hp six-cylinder Diesel engine, has a maximum drawbar pull of 32,600 lb



TDT-60 logging tractor has an extendible apron for loading, and a four-cylinder Diesel engine of 60 hp

ing a frame supporting that portion of the body behind the rear axle. The engine is carried in the rear compartment, with the radiator positioned against the left wall. As seen in the bus on exhibition, this was the 338-cu in. power unit from the ZIL-150 truck, rated in this instance 109 hp at 3000 rpm. It was stated, however, that the new V-6 will be employed when it becomes available. This forward-control, 33-passenger bus has the front I-beam axle suspended by leaf springs assisted by individual sets of coil springs that come into action during excessive overloads. Interior heating is by oil burner.

Tractors

Largest crawler tractor on show, the Diesel-electric DET-250, has a 1708-cu in. V-12 engine with a rating of 300 hp at 1500 rpm. The unusual cooling system employs pairs of radiators for both water and oil, placed vertically along each side of the engine compartment. No fans are used, and air flow is created on the venturi principle. The exhaust pipes, terminating in rectangular exit ducts projecting from the compartment on the outer side of each radiator set, make the forced draft. This arrangement saves the power needed to drive fans, and places the radiator cores in protected positions. Made in Chelyabinsk, the DET-250 weighs 25 tons, has a maximum drawbar pull of 23 tons, and its electric transmission provides a speed range from 1.3 to 12 mph.

A somewhat smaller crawler was designated only as 140, indicating the horsepower at 1000 rpm of its six-cylinder Diesel. Weighing 15 tons, this tractor has a transmission with five forward and two reverse ratios, providing speeds from 1.4 to 6.5 mph. Maximum drawbar pull is 32,600 lb. Each track carries three pairs of sprung bogies, and shoes are available in 27.5- and 35-in. widths. Ground pressures are stated to be 5.9 and 3.4 psi respectively. The vehicle is 208 in. long, 108 in. wide overall, and 110 in. high.

Two logging tractors were exhibited, both being Diesel-powered and said to replace earlier models fueled by wood burned in gas generators. Similar to their predecessors, they have a large apron at the rear that is lowered to the position of a ramp during loading, with a winch dragging the butts of the logs onto it. The larger TDT-60, weighing 23,000 lb, has a four-cylinder engine developing 60 hp at 1500 rpm, and a five-speed transmission giving a maximum drawbar pull of 11,500 lb in first gear. The smaller TDT-40 has a 40-hp engine.

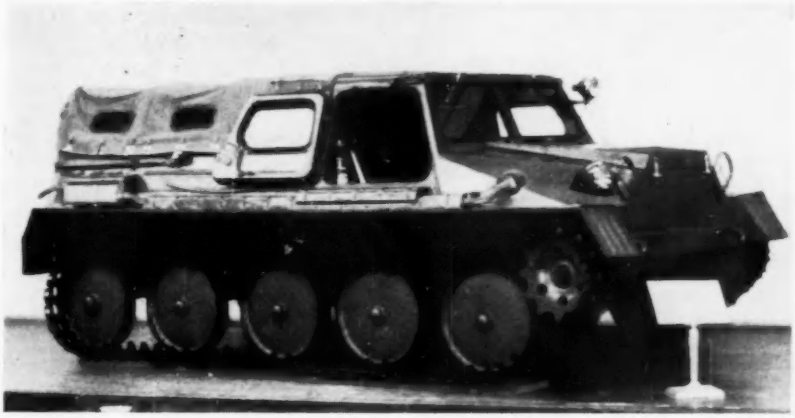
Amphibian Vehicle

Described as an amphibian, the GAZ-47 crawler has a load capacity of nine men or one ton. The tracks are completely submerged when the hull is floating, and forward propulsion is effected by the differential in water pressure against their upper and lower sections. Maximum water-borne speed was stated to be 2.5 mph. The basic Gorkiy 70-hp gasoline engine is used, and the transmission includes a four-speed gearbox and steering clutches. Top speed on ground is 20 mph. This 7800-lb vehicle has been in production since 1955, and it was stated that many of them are in use in the Antarctic.

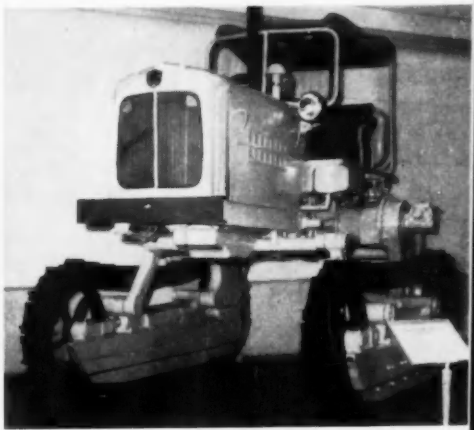
The DT-40X is a special adaptation of a standard crawler made especially for cotton cultivation. It has narrow tracks spaced 79 in. apart for row crop work, and the tractor chassis is raised to give a ground clearance of 36 in. The rear of each track assembly pivots in its drive-chain housing, while its front is supported by arms suspended by a common transverse torsion bar. Engine is a four-cylinder Diesel developing 40 hp at 1500 rpm.

Wheeled Tractors

The tubular-framed DVCSh-16



Amphibian GAZ-47 weighs 7800 lb, and is propelled in water by the track. Capacity is nine men or one ton

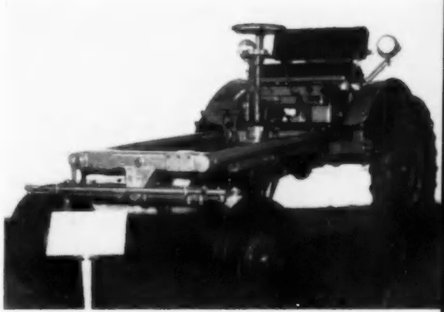


Designed for cotton cultivation, the DT-40X has the narrow tracks spaced 79 in. apart, and a 36-in. ground clearance

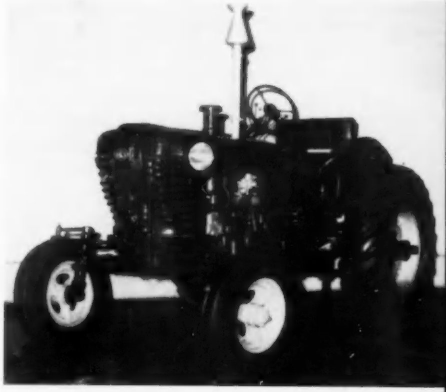
implement-carrier was one of the new Russian wheeled tractors seen at the Moscow exhibition. Mounted behind the bench seat is the blower-cooled two-cylinder Diesel engine of 97.6-cu in. displacement, rated 16 hp at 1600 rpm, and the transmission with six forward and one reverse ratios. There is hydraulic control for the mid-mounted implements. Front track width can be infinitely varied by telescoping the centrally-pivoted axle and the steering rods. The main steering shaft from the vertical column is housed in one of the tubular frame members.

Shown in pre-production form, the VTZ-28 is a medium-weight wheeled tractor with a two-cylinder water-cooled Diesel developing 32 hp at 1400 rpm. Drive is through a double-disk clutch with two pedal positions for disengaging the main transmission and the pto, and a transmission that provides nine forward and two reverse ratios.

Also on display was a self-powered, road-bed-leveling trailer, adapted from the DT-54 crawler as a wheeled vehicle. It is intended for towing by the parent 54-hp Diesel tractor. The trailer's engine drives the rotor of spring-mounted fingers at 280 rpm, cutting a seven foot path up to eight inches deep.



Tubular-framed implement-carrier, the DVCSh-16, has a 16-hp aircooled Diesel engine behind the bench seat



Transmission of the 32-hp Diesel-engined VTZ-28 has nine forward speeds and a two-position clutch that progressively disengages the main drive and pto.

"Soviet Transportation—How It Functions Today," by Dr. Holland Hunter, starts on the following page, followed by "Soviet Transportation—The Role of Trucks, Buses and Aircraft," by Dr. Demitri B. Shimkin and Murray Feshback

SOVIET TRANSPORTATION

How It Functions Today

PART I

By Holland Hunter

ASSOCIATE PROFESSOR OF ECONOMICS

Haverford College

A SOVIET transportation writer has already claimed that in the sputniki the Russians have "a new form of transportation." This is, in any case, visionary, to say the least. Here we shall be concerned with the ordinary forms of transportation in the USSR, and with how they have been working recently. The regular carriers are not, of course, as impressive as the earth satellites, but they have been managing to do their part of the job. To see how, we should begin by noting several key contrasts between Soviet and American transportation.

KEY CONTRASTS

Transportation services are abundantly available in the United States; in Russia they have been in short supply for 30 years. The American pattern is good for travelers and shippers, but can complicate the operations of the carriers. In the USSR, on the other hand, the benefits of abundant transportation services are withheld from users, and carriers can often use the situation to promote their own internal efficiency. This fundamental difference underlies all detailed comparisons between U.S. and USSR transportation.

Another contrast, tying in with the first, appears in the Soviet emphasis on freight transportation. In our transportation system the traveler influence is strong, especially when we see how private cars have stimulated our highway system and passenger travel has supported development of our airways. Soviet authorities have, instead, given top priority to industry, and therefore to freight transportation. Of course carriers can be specialized in both countries—American pipelines don't carry passengers any more than Soviet trolleys carry freight. But the difference in emphasis is striking nevertheless, and it has a good deal to do with Soviet performance.

A third contrast—the one that always astounds American transportation men—is that Soviet railroads are eager to have trucks, barges, aircraft, and buses take business away from them. The government has barely permitted transportation capacity to keep up with demand. There is plenty of business for everybody. Soviet railroads therefore prod the other carriers to handle as much traffic as they can, taking some of the steadily increasing burden from the railroads. At present, however, 83 per cent of total Soviet freight ton-miles and 81 per cent of total Soviet passenger-miles (urban and long-distance combined) are handled by the railroad system.

RECENT PERFORMANCE

The Soviet economy is growing rapidly, and this has meant a steady growth in the demand for transportation. The government has sought to hold down this rising demand but since 1954 the carriers have had to handle freight traffic expanding at an increasing rate. So far, the carriers have succeeded. In 1957 they will handle about 280 billion net ton-miles more freight traffic than they did in 1954. But it is clear that they are all hard-pressed.

The railroads, for example, have a freight traffic density per mile of roadway that is over three times the U. S. average, and at a few points are experiencing higher traffic densities than U.S. railroads have ever confronted. The Russians are now electrifying heavily-traveled trunk lines, or changing from steam to Diesel-electric locomotives; but the changeover is slow and currently many problems of mixed operation are giving difficulty. With physical equipment that is in many respects ramshackle and out-of-date, Soviet railroadmen are straining through intensive utilization and a large operating labor force to stay ahead of the demands placed on them.

The USSR now has about 3.6 million non-military motor vehicles, of which some 2.8 million are trucks, 700,000 are passenger cars, and some 65,000 are buses. As the Nazis found to their sorrow, the highway system is primitive indeed; and while many roads have been paved since 1941, the Russians are still at a very early stage of development in this field.

HOLLAND HUNTER, author of this article, has specialized in analyzing Soviet transportation the past 10 years and has been an advisor to the U.S. Government. In 1956 he was a member of the U.S. delegation to an international conference of specialists on the USSR. His book, "Soviet Transportation Policy," has just been published by Harvard University Press. At one time he served as a research fellow with the Russian Research Center at Harvard University.

During June, 1957 Dr. Hunter toured various sections of European Russia to study Soviet transportation systems, including those in eight major cities. He interviewed several Soviet transportation economists who read galleys for his new book and gave him their comments. In his contacts with the Russian people he found a rise in the tempo of national pride. They overlook poor living conditions and the shortage of consumer goods, and find glory in the accomplishments of the Soviet Union in world politics and science.

The facts and observations in this article—and in the report following it by Demitri B. Shimkin and Murray Feshbach of the Foreign Manpower Research Office—bring up-to-date "Transport—Russia's Achilles' Heel?" by Dr. Hunter in the Sept. 15, 1951 issue of AUTOMOTIVE INDUSTRIES. The 1951 article received international attention, even by the Kremlin hierarchy.

The use of trucks and buses for intercity movement scarcely exists as yet. Trucks are used mainly in and around urban areas for pickup and delivery, the average haul for truck freight traffic being only about seven miles.

Buses and passenger cars share with streetcars, trolleys, subways (in Moscow and Leningrad), and railroads the job of providing transportation for the Soviet urban population—but the volume of movement is small by our standards. Soviet motor vehicles may be up-to-date from the usability standpoint, but in the extent of their civilian use, the USSR is several decades behind most West European countries, to say nothing of Canada or the United States.

Soviet river and sea shipping handles about 12 per cent of total freight ton-miles, including maritime traffic originating or terminating abroad, and the government has been promoting expansion of these carriers. Geography, however, stands opposed to them. The rivers don't run where they are needed, and the seas are not easily linked together on a year-round basis. Recently river carriers have fallen behind in handling added traffic and only a spurt in the foreign traffic of Soviet ships has kept up the water carriers' share of total freight traffic. They play a diminutive role in passenger carriage, for excursion trips and the like, and show no appreciable growth.

Freight and passenger movement by air, on the other hand, has been expanding very rapidly. Soviet air freight movement in 1956 was about three-quarters the volume of U. S. domestic air freight traffic. By contrast, Soviet passenger movement by air in 1956 was only about 8 per cent of the U.S. level. A visiting tourist in the USSR finds air travel a convenient and reliable means of getting around, but only a small minority of Soviet citizens are currently making use of it. The railroads still account for 93 per cent of long-distance passenger movement in the USSR. Soviet petroleum production has grown almost three-fold since 1948, and in recent years pipeline transportation has at long last been expanded to handle crude oil and refined products. The railroads still account for over half of total petroleum ton-miles of freight traffic, but pipelines in 1956 handled some 11 per cent of the total and their share will rise steadily. The change is associated with expansion of "mid-continent" fields between the Volga river and the Ural mountains.

Why has Soviet transportation developed as it has, skimping on the availability of transportation services and leaning so heavily on the railroads? The trend is not accidental. Stalin and his successors have withheld resources from transportation development in order to build heavy industry. The private passenger automobile and all it implies have a low priority. Even the freight transportation necessary for heavy industry has been provided under severe limitations. Basic movement of raw materials, fuel, and intermediate products from enterprise to enterprise has been taken care of, if necessary, through investment in modern equipment. But wherever animal or hand transport could suffice it has been employed. The whole field of materials handling, for example, was ignored until recently.

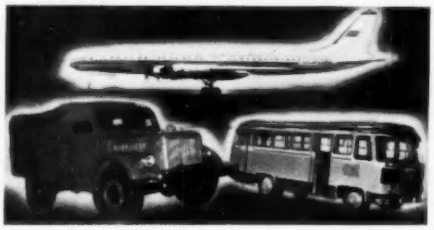
We cannot deny that the policy has produced results. Putting first things first, though brutal and high-cost, has made the USSR a threatening world power. But one major facilitating feature of the process was abundant supplies of labor, and the USSR now faces a serious shortage in new manpower. Hence intra-plant transportation and materials handling problems have begun to receive close attention. The importance of ancillary transportation has at last been recognized. Had needs here been met earlier, my guess is that production would have gained more in efficiency than it lost through diversion of investment.

FUTURE PROSPECTS

The prospect for Soviet transportation, in the short run, is continued growth under continued strain. It appears that automotive vehicle transport, along with air and pipeline transport, will expand more rapidly than the railroads, though the railroads will continue for many years to dominate the scene. And freight traffic will continue to outweigh passenger travel in the scale of government priorities.

In the long run, however, the passenger car may occupy a more important place. During an interview last June in Moscow, a Soviet transportation specialist was kidding me about the "planless congestion" of our big cities, and I admitted that traffic jams were a problem. To my considerable surprise he then went on to predict, cheerfully, that in a few years Moscow's traffic jams would be just as bad as ours!

SOVIET TRANSPORTATION



The Role of Trucks, Buses and Aircraft

PART II

By Demitri B. Shimkin
and Murray Feshbach

FOREIGN MANPOWER RESEARCH OFFICE

U. S. Department of Commerce
Bureau of the Census

WITHIN the past year, the release by the Soviet government of a considerable volume of information, particularly the new statistical handbooks on Transportation and Communications, and on Industry, has permitted greatly improved understanding of Soviet vehicular and air transportation. It is now possible to consider these industries more effectively than before, using summaries of the new data and estimates based on them. In detail, it has become possible to assess equipment stocks, the roles of various carriers, traffic patterns, costs, employment, and salient operating problems. Most important, this new information permits an evaluation of the effects of Soviet transportation policies, especially in the field of automotive transport, upon Russia's economy as a whole.

OVERALL ASPECTS

What conclusions may be drawn from this review?

1. The Soviet transportation system, dominated by direct State controls, differs profoundly in function and structure from that of the United States. In general, it is designed to support industrial needs, with minimal attention to passenger traffic. Within this system, trucks serve as the main short-run carriers and railroads are basic, while a well-developed air freight system carries costly cargo on long runs. Buses are the main passenger carriers in the smaller cities, but are subordinate to electric and steam railroads in large-city and suburban traffic. Air passenger traffic is, as yet, minute.
2. The different carriers vary greatly in efficiency, in comparison with the United States. In general, the inefficiencies of Soviet freight transportation are compensated for by austerity and efficiency in passenger traffic.
3. The system has many disadvantages. The inefficiency of truck transportation limits prime industrial locations to main railroad lines which have expanded slowly. In addition, the effective exploitation of city outlying areas is difficult, as is also the general movement of perishables and small shipments. Weaknesses in passenger transportation impose losses in time and effort for the population. By limiting choices of employment, housing and markets, they lower standards of living. They do, at the same time, promote the controls, compartmentation and stratification desired by the regime. The rigidity of the transportation system, with its limited capacity for evacuation or the employment of substitute routes, is a military hazard. Nevertheless, because the system continues to work, and because a genuine modernization would be extremely costly, radical changes in the pattern of Soviet transportation are not foreseen.

MOTOR VEHICLES

At the end of 1956, the number of non-military motor vehicles in the Soviet Union approximated 3.1 million, including about 2.45 million trucks, 600,000 passenger cars and jeeps (of which 270,000 are owned privately or by collective farms) and 55,000 buses. Although the number of Soviet passenger cars (including jeeps) is only 1.1 per cent that in the United States today, the numbers of trucks and buses amount, respectively, to 24 per cent and 38 per cent of the American quantities. Furthermore, the number of motor vehicles in the Soviet Union is at present almost three times greater than the pre-war peak, and is growing currently at a rate of about seven per cent per year.

Nearly 57 per cent of the Soviet population is still rural and engaged primarily in agriculture, yet motor-vehicle stocks are for the most part concentrated in urban areas. In 1956, only a quarter of the country's trucks were owned by agricultural establishments (collective farms, machine-tractor stations, and State farms). In rural areas, animal-

Mode of Transport	Ton-km. (billions)**			Tons Originated (millions)			Average Length of Haul (km.)		
	1940	1950	1956	1940	1950	1956	1940	1950	1956
Total, All Carriers*	487.4	713.1	1301.2	1563.3	2834.2	5842.1	311.8	251.6	222.7
Railroad	415.0	602.3	1079.1	592.6	834.3	1371.0	700	722	787
River	35.9	45.9	70.2	72.9	91.5	146.8	493	502	479
Pipeline	3.8	4.9	20.5	7.9	15.3	65.3	481	320	314
Sea	23.8	39.7	82.4	31.2	33.7	57.7	763†	1178†	1428†
Auto	8.9	20.1	48.5	858.6	1859.2	4200.9	10.4	10.8	11.5
Air	0.036	0.202	0.504	0.060	0.176	0.374	600	1150	1350

* Excludes animal-drawn transport.
** One metric ton-km. equals 0.68 net ton-miles.
† Average haul, 1928–1937, was 1247 km.
Sources: TsSU; *Transport i svyaz' SSSR. Statisticheskiy sbornik* "Transportation and Communications of the U. S. S. R. A Statistical Handbook," Moscow, 1957, pp. 7, 12, 17, 34, 119, 155, 209, 210; and J. P. Van Zandt (ed.) "World Aviation Annual 1948," Washington, D. C., 1948, p. 501.

TABLE I—SOVIET FREIGHT TRANSPORT OPERATIONS BY CARRIER: SELECTED YEARS

drawn transportation has retained far more significance than in the United States. In 1955, the collective farms alone had 10.9 million horses.

Reliable data on the number of Soviet transport aircraft are not available.

Motor-vehicles and aircraft play vital roles in Russia's transportation system as they do in the United States, but the Soviet system differs fundamentally from the American in purpose and structure. Soviet transportation has the primary mission of servicing heavy industry through the expeditious flow of bulk shipments of raw materials and fabricates. It also is under continuous pressure to economize to the utmost on capital outlays. It is non-competitive, with each carrier having a monopoly of given transport functions. Finally, it is geared in organization and equipment toward quick adaptation to direct military needs.

These long-continued policies have imparted many peculiarities to Soviet transportation as compared with American practice.

FREIGHT HAS PRIORITY

The high priority of services to industry is illustrated by many facts. Most significant is the historic stress upon freight-handling capacity at the expense of passenger traffic. Thus, in 1955, the overall ton-mileage of Soviet freight transport by all land, sea and air carriers, except animal-drawn carts, (Tables I and II) was about 56 per cent of the corresponding figure for American domestic traffic alone; while passenger traffic (Tables III and IV) was only about 10 per cent as great.

Furthermore, nearly 1.5 million transport workers (excluding cart-drivers and intra-plant personnel) were employed directly by industry in 1955. This number constituted 30 per cent of the total directly engaged in transportation within the entire Soviet civilian labor force. Industry employs, in addition to this number, 140,000 drivers of animal-drawn carts; 270,000 crane, fork-lift truck, and electric-car operators; and 50,000 riggers and others operating and servicing hoisting devices.

A third of the transport workers in industry (including cart-drivers and intra-plant personnel) are employed by the metallurgical, fuel and wood industries; another 15 per cent by the machinery and metalwares industries; and 38 per cent by the food, textiles, apparel and shoes industries; with the remainder scattered among smaller employers.

Finally, even the traffic of common carriers is heavily industrial. For example, bulk materials such as coal, inert fillers and clay constituted 90 per cent of the tonnage hauled by the Moscow City Trucking System (Glavmosavtotrans) in 1955; vegetables made up six per cent of the cargo, and flour the remaining four per cent.

LOW CAPITAL OUTLAYS

Soviet efforts to minimize capital outlays in transportation have had numerous effects. The most pervasive have been in the handling of freight. The railroads, on one hand, must require the immediate loading and unloading of cars in order to maintain good turn-around time (and hence, low rolling stock requirements) despite antiquated equipment. Industrial plants, plagued by difficulties in proper tooling and power supplies, devote minimal investment efforts to the auxiliary phases of the production cycle, such as packing, storage and transportation. Employment in industrial freight handling has soared. In 1955 it reached 920,000 persons, compared to 150,000 in 1936. Over that 20-year period, the rise of employment in freight handling has, in short, been 3.4 times as great as the increase in the number of production workers, and nearly 2.3 times as great as the growth in the volume of industrial output (measured by an index using Soviet 1934 value-added weights).

Reluctance to invest has, to some degree, been compounded by conservatism. The Soviet railroads have often been progressive, within their resources. As Holland Hunter has pointed out, these carriers have adopted centralized control and other advanced techniques on a limited scale. In contrast, the development of pipelines, which would bring about a really dramatic increase in transportation efficiency, has been very slow. In 1956, the length of installed pipelines aggregated only 7200 miles, compared to over 140,000 in the United States. Pipeline traffic, which in volume amounted to perhaps six per cent of the American traffic, constituted little more than a tenth of the Soviet total ton-mileage of petroleum and its products (Table II). Nonetheless, the 1956 level of transport by pipeline does represent a sharp rise since 1950.

ROLES OF CARRIERS

What roles have been assigned to the various carriers? The overwhelming importance of the railroads for the nation's intercity freight transport is clear (Table I). As a matter of fact, the share of railroads in national freight

ton-mileage has varied only between 82 and 85 per cent over the past two decades. Soviet railroad ton-mileage in 1955 was five per cent greater than the American.

The rivers supplement the railroads on favorable routes, with 60.5 per cent of the 1955 traffic falling to the Volga-Kama system which connects Central Russia and the Urals with the Caspian Sea. Timber and building materials constitute over 70 per cent of river cargo. Despite considerable Soviet efforts to improve internal waterways, river traffic has risen more slowly than that of other carriers since 1950. Limited freight-handling capacity, seasonal closure by ice, and inadequate storage facilities appear to have been responsible.

Pipelines serve to ship oil from producing fields to major refineries or shipping points. The network is concentrated largely in the Caucasus, and between the Volga and Urals, with an important line recently completed to the large new refinery at Omsk, in Western Siberia. Oil also constitutes 43 per cent of sea cargoes; coal, ores, and building materials another 36 per cent. The Caspian and Black Seas each carry 35 to 40 per cent of the total tonnage of Soviet sea shipping; the Northern sea route and other long hauls still have little commercial significance.

Trucks and aircraft perform distinctive functions. Trucks perform virtually the entire job of the initial collection and final distribution of goods—a significant fraction of farm products excepted. But intercity truck traffic is practically absent. In consequence, while over 70 per cent of the freight tonnage originated in the Soviet transportation system moves by truck, the average distance hauled is only 7.1 miles.

In contrast, Soviet airlines have specialized in the long hauls of valuable cargo. Since 1940, the average length of air haul has risen from 370 to 840 miles. The tonnage of freight and mail carried has increased six-fold over the period. As a result, the air-freight traffic of the Soviet Union is now about 90 per cent as great as that of our scheduled air lines alone, and three-quarters as great as that of all U. S. domestic air carriers.

PASSENGER TRAFFIC

The volume of passenger traffic in the Soviet Union must be partially estimated, since fully explicit data on streetcars, trackless trolleys, subways, noncommercial buses and passenger cars are not published. It is believed that these omitted carriers now handle about one-third of all Soviet passenger traffic. Nevertheless, even with these carriers included, Soviet urban and rural traffic volume in 1956 totaled only some 160 billion passenger-miles, or a tenth of the American volume.

For meaningful analysis, the pattern of Soviet passenger traffic must be differentiated into city, suburban and long-haul. In city traffic, two-thirds of all passenger-mileage is still handled by streetcars, trackless trolleys and subways. However, in recent years this proportion has declined, as it has in the United States. In 1940, it exceeded 90 per cent. On a per capita basis, the present volume of Soviet city passenger movements, although about a quarter higher than before World War II, approximates an eighth of the American. In the 30 to 50 cities with streetcar, trolley and subway facilities, as well as expanding bus and passenger car traffic, problems of congestion are arising. For example, in 1954, peak-hour bus traffic alone averaged about 1800 vehicles on five main routes in Moscow. This may be compared with the metropolitan American average—a main-road peak of 2900 per hour for all vehicles.

In the smaller Soviet cities, automobile traffic appears still to be light, with public transportation facilities grossly inadequate. Until recently, the average citizen had to walk to work or to market. In the last six years, however, bicycle and motorcycle production have soared—a total of 7.0 million bicycles and 680,000 motorcycles having been sold to urban customers during this period.

Suburban railroad and bus traffic, in passenger miles, is estimated to be some 40 per cent as great as city traffic. Over half is commuter traffic, largely in the environs of Moscow, Leningrad, Sverdlovsk and Baku. But the volume of this traffic (Table III) has grown more slowly than the urban population. Apparently suburban, let alone rural, living is not yet a prominent feature of Soviet metropolitan culture.

Trends in long-haul and rural passenger traffic differ sharply from those already sketched. Buses play an insignificant role. The Moscow Passenger Autotransport Establishment, which operated 11 main intercity routes, including Moscow to Khar-kov, had only 65 buses and handled only 86 million passenger-miles in 1955. Nor is private passenger-car traffic important, judging from the fact that only 17 per cent of private car sales go to rural customers. On the other hand, bicycles and motorcycles have become commonplace in the Soviet countryside, with rural sales totaling nearly 6.8 million and over 420,000 respectively, in the years 1950-56. As a consequence of increased use of bicycles and motorcycles for rural transportation, the pattern of railroad traffic has shifted from local traffic more toward express runs and thus to a lower number of longer trips than before the war. However, railroads still account for more than 93 per cent of the commercial passenger traffic. Water transportation has a relatively fixed, auxiliary function.

Air travel has multiplied nine-fold in terms of the number of passengers, and doubled in terms of the average trip-length since 1940. Nevertheless, it accounts for only 2.6 per cent of long-haul commercial travel, and is but eight per cent as great as American passenger air traffic. Obviously, while the Soviet Union has produced interesting models of jet air transports, its operating capacity in this field can satisfy little more than the needs of officialdom.

MILITARY REQUIREMENTS

Underlying the civilian roles of Soviet transportation is a required adaptability to military purposes. In Soviet practice, this has meant that civilian transportation equipment must be compatible in design with military equip-

	(In Billion ton-km.)*					Percent of Total Traffic	
Year	Railroad	Sea	River	Pipeline	Total	Railroad	Pipeline
1940	36	14.4	12.1	3.8	66.3	54.5	5.6
1950	52	11.9	12.0	4.9	80.8	64.8	6.0
1956	112	39.6	15.7	20.5	187.8	59.6	10.9

* One metric ton-km. equals 0.68 net ton-miles.

Source: TsSU: *Transport i svyaz' SSSR. Statisticheskiy sbornik* "Transportation and Communications of the U. S. S. R. A Statistical Handbook," Moscow, 1957, pp. 35, 97, 99, 119, and 210.

TABLE II—TRANSPORTATION OF PETROLEUM AND ITS PRODUCTS, BY CARRIER: SELECTED YEARS

ment, and even adaptable to direct military employment, with the civilian economy bearing all extra costs and inconveniences incurred therefrom.

For example, flat cars, vitally important for troop movements, have constituted 15 per cent of the freight cars built in the Soviet Union since 1937. In the United States, flat cars comprise only four per cent of the number of freight cars. Again, the high development of Soviet air freighting simply represents peacetime use of military air lift. Soviet civilian trucks, on the contrary, are inadequate compromises, not well adapted to off-the-road use or to the pick-up-and-delivery functions in which they specialize.

OPERATING COSTS

Given the variety of non-economic considerations in Soviet transportation, it is hardly to be expected that minimum costs should be achieved. The spread in costs between the various commercial carriers is extraordinary. According to official data, the costs of a metric ton-kilometer of freight moved (excluding loading and unloading) ran as follows in 1955: railroads (broad-gage, common carriers only), 3.932 kopeks; sea, 2.970 kopeks; river (common carriers only) 3.66 kopeks; and truck, 75.6 kopeks (common carriers, 51.0 kopeks). Apart from these direct costs, freight-handling expenditures can be estimated conservatively at 1.4 rubles per metric ton of freight originated.

Profits to State freight-transport establishments approximated 20 billion rubles during 1955. In all, the cost of Soviet freight transportation in 1955 was about 106 billion rubles. These outlays, which exclude the undoubtedly significant costs of animal-drawn transport, made up 11 per cent of the gross value of Soviet industrial output in 1955; and value-added by freight transportation amounted to over five per cent of the gross national product. Because the need to use higher-cost transportation has increased despite intense Soviet efforts to economize, Soviet outlays for freight transportation (measured in 1955 rubles) rose four-fold between 1937 and 1956, while ton-miles only tripled.

No time series on American freight costs is available. However, in 1947, gross outlays for freight transportation were substantially lighter. They made up 3.4 per cent of the gross value of industrial output; and freight transportation contributed about 1.6 per cent to the gross national product. The cost structure of American transportation also is different—with far less spread between railroads and trucking, with waterways operating at a fraction of railroad costs, and with freight-handling being relatively cheap.

PECULIARITIES

These differences point up a series of peculiarities in Soviet transport operations. First, the ton-mileage of freight moved per unit of industrial output is about 40 per cent higher than in the United States. That situation has two causes: a considerable and growing locational separation between industrial raw-materials producers and fabricating centers; and the continued predominance of solid fuels in the national energy balance. Second, the State utilizes its monopoly of freight transportation as a means of hidden taxation. Third, by permitting the railroads to minimize services and by forcing railroad customers to load and unload freight cars immediately, the State has forced other carriers to subsidize railroads indirectly. Fourth, freight-handling costs are high. Finally, trucking is very expensive; in 1955, trucking costs comprised over 40 per cent of Soviet direct transportation expenditures.

SERVICEABILITY OF TRUCKS

A basic reason for the inefficiency of Soviet trucking lies in the still-primitive condition of Russia's highways. In 1956, Soviet paved roads totaled only 29,000 miles; all other surfaced roads, 104,000 miles. This, and poor maintenance, results in low operating indices for equipment.

Although the average annual run per truck is modest, 7700 miles in 1955 (compared to 10,697 in the United States), and the average age of trucks in service is about 4.5 years (compared to 6.7 in the United States), over a quarter of the trucks are constantly undergoing repairs. The proportion of trucks in service is further reduced by a severe shortage of drivers, who are consequently required to work as long as 350 to 400 hours per month, i.e. 12 hours a day and seven days a week. In all, the trucks in operation constituted only 54.4 per cent of the total stock in 1956.

Finally, the organization of trucking is poor, with centralized dispatching and maintenance little used. One

	Total City and Suburban Index (1950=100)		City: Common Carrier Buses		City: Trolleys, Trolley-Buses and Subways		Suburban: Common Carrier Buses		Suburban: Railroads	
Year	Fares	Passenger km.	Passengers (million fares)	Average Haul (km.)	Passengers (million fares)	Average Haul (km.)	Passengers (million fares)	Average Haul (km.)	Passengers (million fares)	Average Haul (km.)
1940	106	115	(530)*	(3.8)*	(7620)	Est. 6-8**	(60)*	(23)*	1003	26
1950	100	100	1001	3.8	6700	Est. 6-8**	52	26 4	955	22
1956	188	172	5201	3.7	9500	Est. 6-8**	257	28.1	1414	23

* The estimates of city and suburban bus traffic, and average lengths of haul, in 1940 are allocations of two official figures, i.e. a total of 590 million passengers and an average haul of 5.7 km. per passenger, for all bus traffic.

** Estimated on the basis of calculations of vehicle stocks, vehicle-mileage, and capacity, partly utilizing U. S. data as a model.

Source: TsSU: *Transport i svyaz' SSSR. Statisticheskiy sbornik* "Transportation and Communications of the U. S. S. R. A Statistical Handbook," Moscow, 1957, pp. 41, 42, 175, 178, 184, 185, 187, and 188.

TABLE III—PASSENGER TRAFFIC, CITY AND SUBURBAN: SELECTED YEARS

	1940	1950	1956
Passenger-km. (in billions):			
Total	78.2	71.7	117.9
Railroad	73.3	66.8	109.9
Air	0.170	1.015	3.1
Water (sea and river)	4.7	3.9	4.9
Number of Passengers (in millions):			
Total	416.5	267.2	337.1
Railroad	340	209	244
Air	0.359	1.400	3.16
Water (sea and river)	76.1	56.8	89.9
Average haul (in km.):			
Total	188	268	350
Railroad	216	320	450
Air	475	725	980
Water (sea and river)	62	69	55

* All traffic other than city and suburban.

Source: TsSU: *Transport i svyaz' SSSR. Statisticheskiy sbornik* "Transportation and Communications of the U. S. S. R. A Statistical Handbook," Moscow, 1957, pp. 12, 41, 95, 116, and 209; and J. P. Van Zandt (ed.) "World Aviation Annual, 1948," Washington, D. C., 1948, p. 501.

TABLE IV—LONG HAUL PASSENGER TRAFFIC:* SELECTED YEARS

consequence has been a low utilization of truck capacity, with 47 per cent of truck mileage run unloaded. On the other hand, Soviet truck drivers have achieved increased productivity per man by working longer hours. For common carriers, driver productivity was about 41,500 ton-miles, about a fifth of the comparable American figure. This may be compared with the productivity (measured in traffic per direct transport worker) of Soviet railroads, which is one-quarter the American level.

BUS SERVICE

Excessive Soviet expenditures on freight transportation, are largely balanced by austerity in passenger transportation, and in the use of vehicles by commercial services. Soviet gross outlays for passenger transportation in 1955 were perhaps 15 per cent as great as those for freight; in the United States in 1947, on the other hand, passenger transportation expenditures were more than twice as great as those for freight transportation. In addition, the efficiency of public passenger transportation appears to be high. Between 80 and 90 per cent of the buses are in operation. They are intensively used (5500 hours per year in Moscow), so it is evidently traffic congestion and insufficient power that limit the speed, and hence, the annual run of buses to about 18,000 miles, or about 55 per cent of the average for American commercial buses. Annual productivity, in fares per person employed, exceeds half the American level.

In streetcar, trackless trolley and subway operation, on the other hand, Soviet labor productivity runs 10 to 20 per cent ***higher*** than in the United States. Differences in operating conditions account partly for the great gap between the efficiency of Soviet freight and Soviet passenger transportation. Soviet buses operate on streets and paved roads, under centralized control; Soviet streetcars use their capacity fully. But perhaps most important is the concern for cost versus maximum effort in the two instances.

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An Evaluation of RUSSIA'S MISSILE PROGRAM

By Richard E. Stockwell

WHEN WORLD WAR II came to an end in Europe, Russia and the Western Allies inherited the fruits of Germany's missile development program. The Germans had missed on the timing of this important technological development, bringing it up to operational status too late in the war to benefit anyone but their captors.

Both Russia and the Western Allies got complete data on German progress, and while most of the top men from Germany's missile program came to the West, the Russians did take over a few such men and a great many trained and skilled workers. More important, the Soviets launched a program even as they celebrated the end of World War II to catch up with the West in aircraft, nuclear weapons and missiles. We already know much of their progress in the aircraft and nuclear weapons field, and only in recent months have the Russians seen fit to tell us how well they have done with missiles.

Such German scientists and engineers as they got, and who had missile experience or had worked in related fields, were taken to Khimki and to Ostashkov at the end of the war while rocket engine specialists ended up at Kuibyshev. By the end of 1946 most of the truly skilled Germans in the fields of chemistry, aeronautics, powerplants, missiles and atomic research had been taken to the USSR.

It has been indicated by some of the German missiles experts who have since returned from Russia that they contributed only component designs which the Russians took over and worked into new missile designs as they saw fit. German technicians from Peenemunde, the big German missile testing center during World War II, taught the Russians the secrets of the V-2 and helped them improve it to some extent. The Russians sought to increase its range and reduce its weight, projects in which they evidently had some success.

The Russians long have shown an interest in missiles. They can make very legitimate claims to early fame in advanced thinking about using rockets to travel to the moon and escaping the earth's gravitational field. But most of their work had been of a theoretical nature, and the German hardware, designs and experience which they gained at the end of World War II acted like a shot of adrenalin on them in this field of weapons development.

They got a host of missiles from the Germans, all of them in various stages of development. There were the V-1 and V-2 missiles, several anti-aircraft or barrage missiles, and three or four different types of glide bombs. In addition, there were plans for larger missiles as well as the famous Saenger glide bomber concept.

Large Family of Missiles

From these, and as a result of their own extensive development efforts, the Russians have developed a large family of missiles. Anti-aircraft missiles today ring such cities as Moscow. Generally, the Soviets have divided their air defenses by altitude, and have assigned all altitudes below 50,000 to their jet aircraft and all altitudes above 50,000 feet to guided missiles.

One surface-to-air missile the Soviets have in their arsenal is similar to the U. S. Army's Nike. They also have an Honest John type of surface-to-surface missile, special, improved versions of the German Wasserfall, designated the C-2, used against both aircraft and ground targets. One or more Soviet anti-aircraft missiles is believed equipped with a nuclear warhead for use against aircraft flying at high altitude.

The Russians put missiles on aircraft and used them against German tanks during World War II. This technique has been further developed since then, and some aircraft, like the Yak-25 (NATO code-named Flashlight), is equipped with air-to-air missiles fed automatically into a firing tube.

In the V-2 the Russians got the essentials of an intermediate range ballistics missile. Originally they designated their version of the V-2 as the M-101, but within the past few years designations have been changed, and this missile now is known as the T-1. In the latest improved version it has a thrust of 77,000 lb and a range of about 500 miles. The Russians use liquid fuel in the missile just as did the Germans.

At the same time they were improving the V-2, the Russians also developed a missile powered by a turbojet. It was fired in the Arctic, across one of the four major missile testing ranges available in that vast country. It flew about 750 miles. As far as is known this missile

RUSSIA'S MAJOR MISSILES

Designation	Type	Engine Size	State of Development
T-1	IRBM	77,000 lb thrust	Army — Operational
T-2	IRBM	225,000 lb thrust	Army — may be operational
T-3	ICBM	Two T-2s; one T-1	Army — advanced developmental
T-3A	Sputnik	Two T-2s, modified plus third stage	Academy of Sciences
T-4	Hypersonic Bomber	Uncertain—test vehicle	Academy of Sciences, or special institute.
T-4A	Hypersonic Bomber	For production, possibly by 1959 800,000-1,000,000 lb	Academy of Sciences, or special institute.

About the author—Richard E. Stockwell, author of the book SOVIET AIR POWER, visited Moscow, Leningrad and Tiflis in the USSR during the summer of 1957. Mr. Stockwell was on leave of absence from General Electric Co. where he is presently employed as management information analyst at the Aircraft Gas Turbine Division in Cincinnati.

never was put into production, possibly because the Russians were having trouble with their turbojet engines.

The T-1 became the building block, a proved starting point for the Russians. In keeping with their usual practice of scaling up proved designs (witness the Tu-104 to Tu-110 to Tu-114 transports), they next developed the T-2, and IRBM in the 1000 mile range category. It has a rocket engine that develops between 200,000 and 250,000 lb thrust and burns liquid fuel.

T-2 is a significant weapon in the Soviet ground forces arsenal where it began to make its appearance about the time of Stalin's death, in 1953. The missile was the largest put on display during celebration of the 40th anniversary of the Bolshevik Revolution last November.

For Army field use T-2's fuels-logistic problem must weigh heavily on the Reds. Liquid oxygen and kerosene or some other hydrocarbon used in this missile are not easily handled in the field. This is an indication that the Russians perhaps have not yet developed satisfactory solid fuels for such large missiles.

T-2 logically leads to T-3, the designation of the Soviet intercontinental ballistics missile, believed capable of 5000 miles. According to the Soviets the missile can be guided accurately to its target. It is a three stage affair, with a T-2 very likely serving as the second stage and a T-1 possibly serving as the third stage. It is equipped with a nuclear warhead, indicating that the Russians have perhaps done as well as the U. S. in reducing the size of nuclear warheads.

Soviet Earth Satellite Project

The Soviets were so certain of their development program in the missile field some three years ago that they confidently announced to the world that they had established a committee to put up an earth satellite. The announcement came three and a half months before a similar proclamation in the U. S. for Project Vanguard. The Russian committee was headed by Academician Leonid Sedov, and included Peter Kapitsa, famed Russian-born, English-trained physicist. Russian rocket engine expert, I. A. Merkulov, also was a member of the committee.

The Russian plan for launching their Sputniks, according to such information as they have made public, indicates that it was done in about the same manner that the U. S. has planned to launch Vanguard. They used a three-stage rocket, in which the first stage got the satellite vehicle up to a speed of 4500 mph and turned at an angle of 45 degrees from the surface of the earth. The second stage then increased the speed up to about 12,000 mph.

The third stage then coasted until it was traveling in a course that more or less paralleled the surface of the earth. Then the third rocket was fired and the missile then achieved a speed of something like 18,000 mph, after which the protective nose cone was blown free and the satellite was pushed out by a small charge.

In keeping with their usual pattern of standardizing as many military and civilian production items as possible, the Russians no doubt used some of their ICBM equipment to launch their satellites. This has given them an advantage in terms of technical development time. They designate the launcher for their Sputniks as T-3A.

Rocket Engine for Hypersonic Bomber

In recent months there have been several reports that the Soviets have much larger rocket engines under development that will produce over 800,000 to a million pounds of thrust. Such powerplants would be useful in launching a hypersonic bomber that could be shot up to great heights, and then set in motion around the earth, returning to its launching site in a long glide. Part way around the earth such a bomber could unload nuclear weapons on almost any country selected as a suitable target.

The T-4A is the hypersonic bomber with an attack capability that would require the large engine. The T-4 is simply the prototype's designation powered by an unknown engine.

From what they showed the world in the last few months of 1957 it is evident that Russia has beaten us in the first round of the missile race. They got there first, and quite aside from the propaganda value of such an achievement, it would indicate that at this stage of the competition they are ahead of us in the capability of producing large ballistics missiles.

They have achieved this in several ways. First, they got into the development of missiles soon after World War II and not once did they break their program or cancel projects simply for a lack of funds. Secondly, they concentrated on fewer projects instead of scattering their shots over a great many. This meant that they could concentrate their more limited talent and facilities. Third, they standardized their missile elements as much as possible. Thus, it was possible for them to launch an earth satellite by using military hardware in part, instead of undertaking a wholly new project with its attendant development costs and time. Finally, they had a clear purpose in mind—a purpose which their Communist doctrine gives them—and so they experienced fewer of the haunting, delaying doubts that so frequently plague U. S. leaders about the usefulness and importance of costly new weapon systems.

Of course the Russians aren't through yet. Even before this appears, the Soviets may launch another satellite of even larger size. Peter Kapitsa, the Soviet physicist, has indicated that such a launching has been scheduled. And he also has said that the Russians would have no trouble in placing a missile on the moon almost any time that they wanted to do so.

Special Reports on Russian and Satellite Industries SEE PAGE 108

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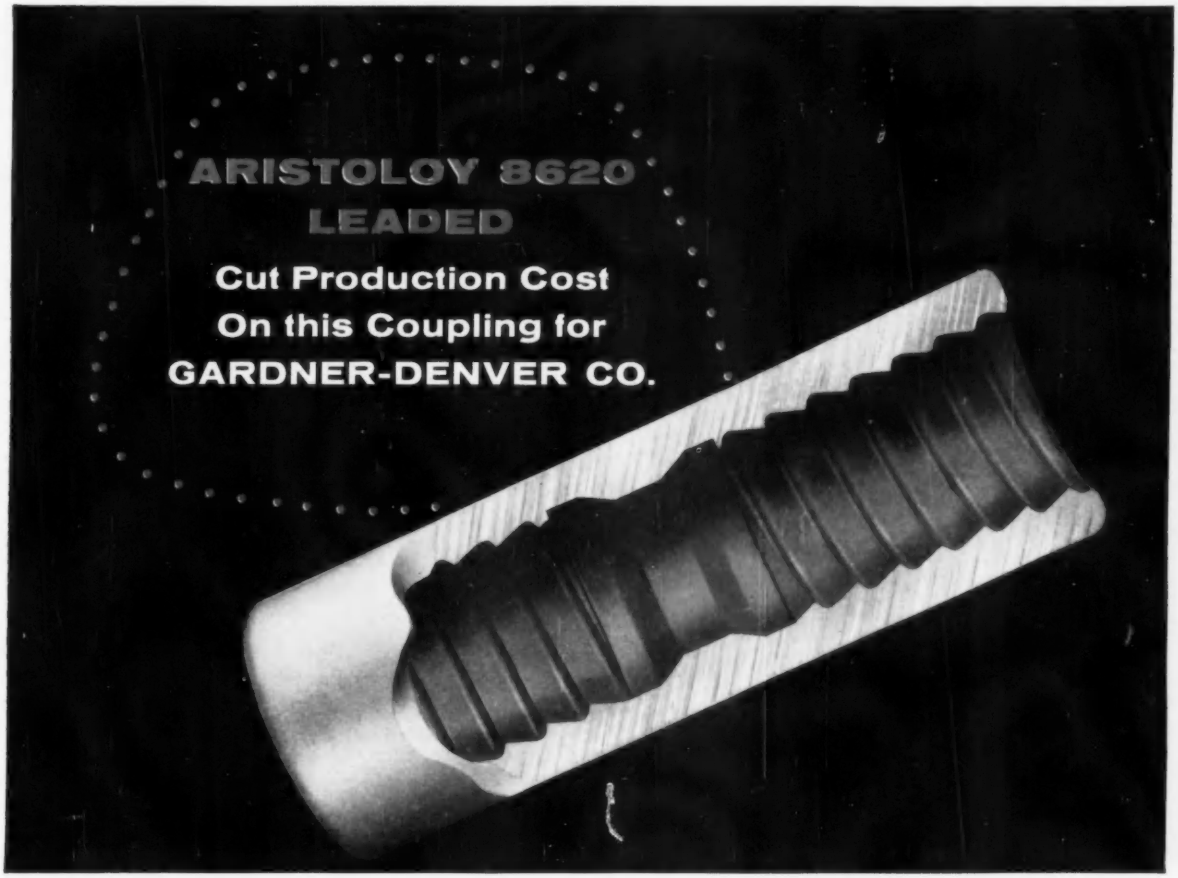

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Spindle Speed R.P.M.	246	301
Feed I.P.R.	.0081	.0081
Machine Speed S.F.M.	120	150
Drill Speed S.F.M.	65	80
Minutes Per Piece	1.59	1.29

Tool Life Increased 35%

TURRET LATHES

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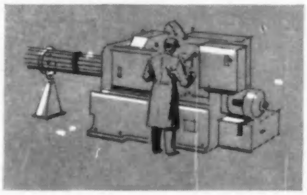
Spindle Speed R.P.M.	296	496
Feed I.P.R.	.021	.021
Machine Speed S.F.M. (drilling & boring)	85	118
Minutes Per Piece	2.31	1.91

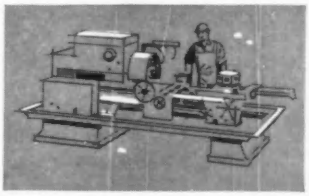
Tool Life Increased 35%

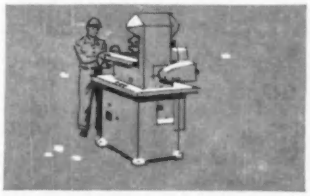
HOB MILLS (Threading)

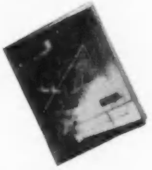
Hob Speed S.F.M.	273*
Feed I.P.R.	11.8
Minutes Per Piece	1.84

*Maximum speed for machine. Changing to leaded Aristoloy brought about no improvement in machining time. However, tool life was increased 40%.









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	Part 2 — Aug. 15, 1950
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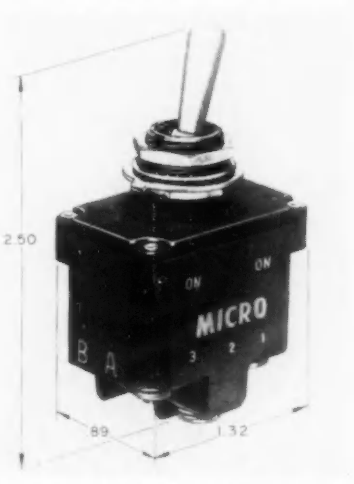
NEW PRODUCTS
AUTOMOTIVE-AVIATION

FOR ADDITIONAL INFORMATION, please use reply card on PAGE 105

Toggle Switches

Toggle switches designed for long lasting life on aircraft feature integral terminals, high impact strength and improved sealing. A silicone seal



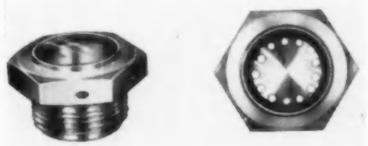
used between the bushing and toggle lever, and a non-hardening silicone sealant used between the case and cover insures against dust or moisture entering the chamber.

The chromium-plated brass toggle lever has anti-rotation control and the plastic case will resist carbon tracking from an electrical arc. The "TL" series include single-pole and two and four-pole circuitry models. They are rated at 20 amp, 30 vdc, resistive load. *Minneapolis-Honeywell Regulator Co.*

Circle 30 on postcard for more data

Oil Level Indicator

The reflecting surface of a new fluid-level sight-glass shows the presence of liquid. Located behind the



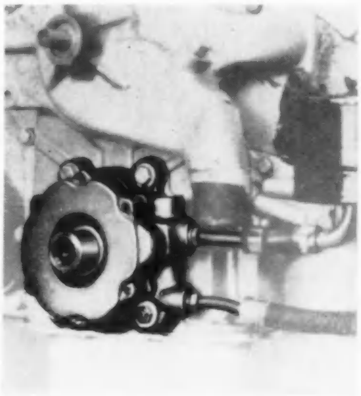
transparent window the reflector reveals the presence of oil in gear cases, or can be used to show liquid level in other types of housings, even in dark locations. Installation of the sight glass requires only a suitable tapped hole. *Technical Development Co.*

Circle 31 on postcard for more data

Power Steering Pump

A new power steering pump, mounted on the engine front cover, is driven directly by the crankshaft. The pump is said to save engine compartment space by eliminating the need for a mounting bracket, belt and drive pulleys.

Utilizing an integral regenerative supercharged system, the pump is capable of operating throughout a speed range of 425 to 4600 rpm. Capacity at 1200 rpm is rated at 6.9 gpm. Also contained in the pump is an integral flow control and a pressure relief valve. Weight is 12 lb.



Dimensions are 5½ in. in diameter, excluding mounting bosses, by 3½ in. deep. *Vickers, Inc.*

Circle 32 on postcard for more data

Electric Engine Starter

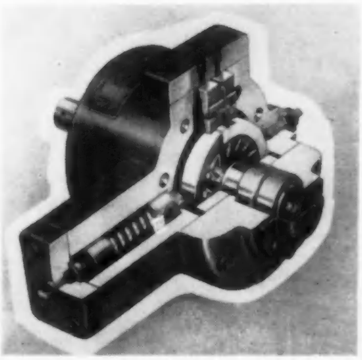
Model 850, an electric starter for engines up to and including 4 hp having a maximum displacement of

approximately 11 cu in. operates on dc only and provides clockwise rotation. It enables pushbutton starting, using either an integral or remote switch. Applicable to gasoline engine powered equipment such as pumps and sprayers it can be used as a replacement kit or be incorporated into the design of new machinery. It is powered by a 12 v battery. *Fairbanks, Morse & Co., Magneto Div.*

Circle 33 on postcard for more data

Variable Vane-Type Pump

Model S, a new variable volume vane-type pump for hydraulic circuit power applications has a 10 gpm capacity. It is designed to operate at 1000 psi and 1800 rpm. The pump is subplate mounted and provides a flex-

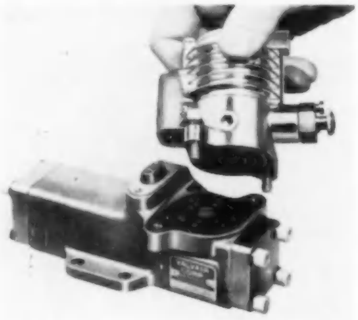


ible source of power for a variety of machine applications. *Racine Hydraulics & Machinery, Inc.*

Circle 34 on postcard for more data

Plug-In Control Valves

Featuring built-in plug connectors for fast automatic connection of electrical circuits, a line of plug in type ¼ in. 4-way control valves were de-



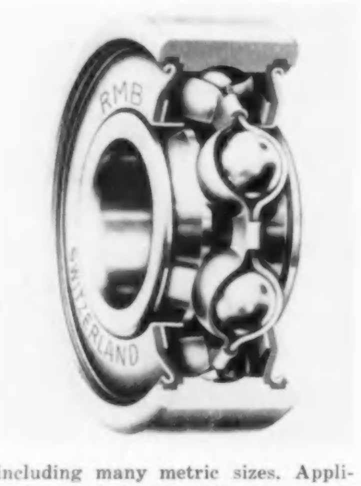
signed for control of smaller devices. They are available in both single and double solenoid types for manifold or subbase mounting.

Named Speed King, the valves were designed for 30 to 250 psi air service and are offered with solenoid coils for ac or dc, any voltage. Cylinder ports and inlet are tapped ¼ in. NPT; exhaust is tapped ⅜ in. NPT. Manual override for use during machine set-up is optional. *Valvair Corp.*

Circle 35 on postcard for more data

Miniature Bearings

Miniature ball bearings made to ABEC-1 tolerances are available in sizes ranging from 3/16 to ½ in. OD,



including many metric sizes. Applications include cam followers, use in potentiometers and electric motors. This new series can be furnished with standard or special axial clearances. *Landis & Gyr, Inc.*

Circle 36 on postcard for more data

Conversion Coating

A conversion coating for zinc plating having a minimum of iridescence can be applied over both barrel and rack-plated parts. In making up a typical bath, the basic product, in the form of a powder, is mixed with nitric acid (3 lb of powder to 1½ gal of acid) for each 100 gal of working solution. During the coating operation, the bath is operated between 80 to 100 F, the parts being immersed from 5 to 25 seconds, with slight agitation. The formulation of the coating is called Iso-Lok ZDP. *Wagner Brothers, Inc.*

Circle 37 on postcard for more data

Precision Flow Switch

Installed in aircraft, a new precision flow control switch indicates fuel transfer from auxiliary to main tanks and signals completion of the transfer. Designated Model FS-26 it is an inline device and is no bigger than the line into which it fits. The device is sensitive to flow at rates as

low as ½ gpm in sizes from one to two inches. Model FS-26 will operate in temperatures from minus 100 to 450 F. *Potter Aeronautical Corp.*

Circle 38 on postcard for more data

Direct Pressure Clutch

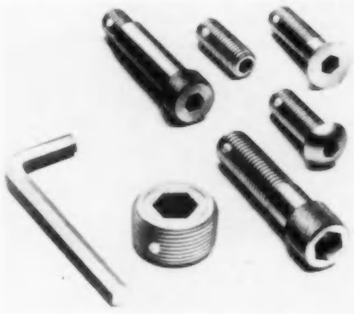
The 14 in. DP, a heavy duty direct pressure clutch, is equipped with a stamped steel cover which provides reduced weight and protection against centrifugal burst. It is available for use with either flat or pot-type flywheels. The two-plate clutch has slots rather than driving pins, engaging the intermediate plate to the flywheel. When the clutch is disengaged, the intermediate plate springs push the intermediate plate against a set of screw stops, providing positive separation. The clutch is for use in heavy-duty trucks, buses and off-the-highway vehicles. *Lipe-Rollway Corp.*

Circle 39 on postcard for more data

Self-Lock Socket Screws

Self-locking socket head cap screws are available in all diameters from microsize No. 0 to fasteners as large as 1½ in. in diameter. They are made self-locking by a nylon pellet inserted in the threaded section of the screws.

The nylon pellet is resistant to water, commercial solvents, alcohols, oil and boiling 40 per cent caustic

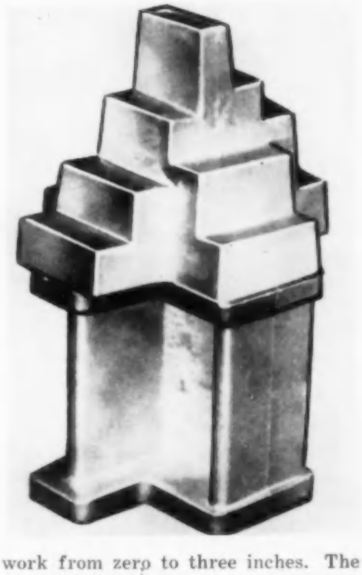


soda. Locking action is retained at temperatures from minus 70 to 250° F. *The Cleveland Cap Screw Co.*

Circle 40 on postcard for more data

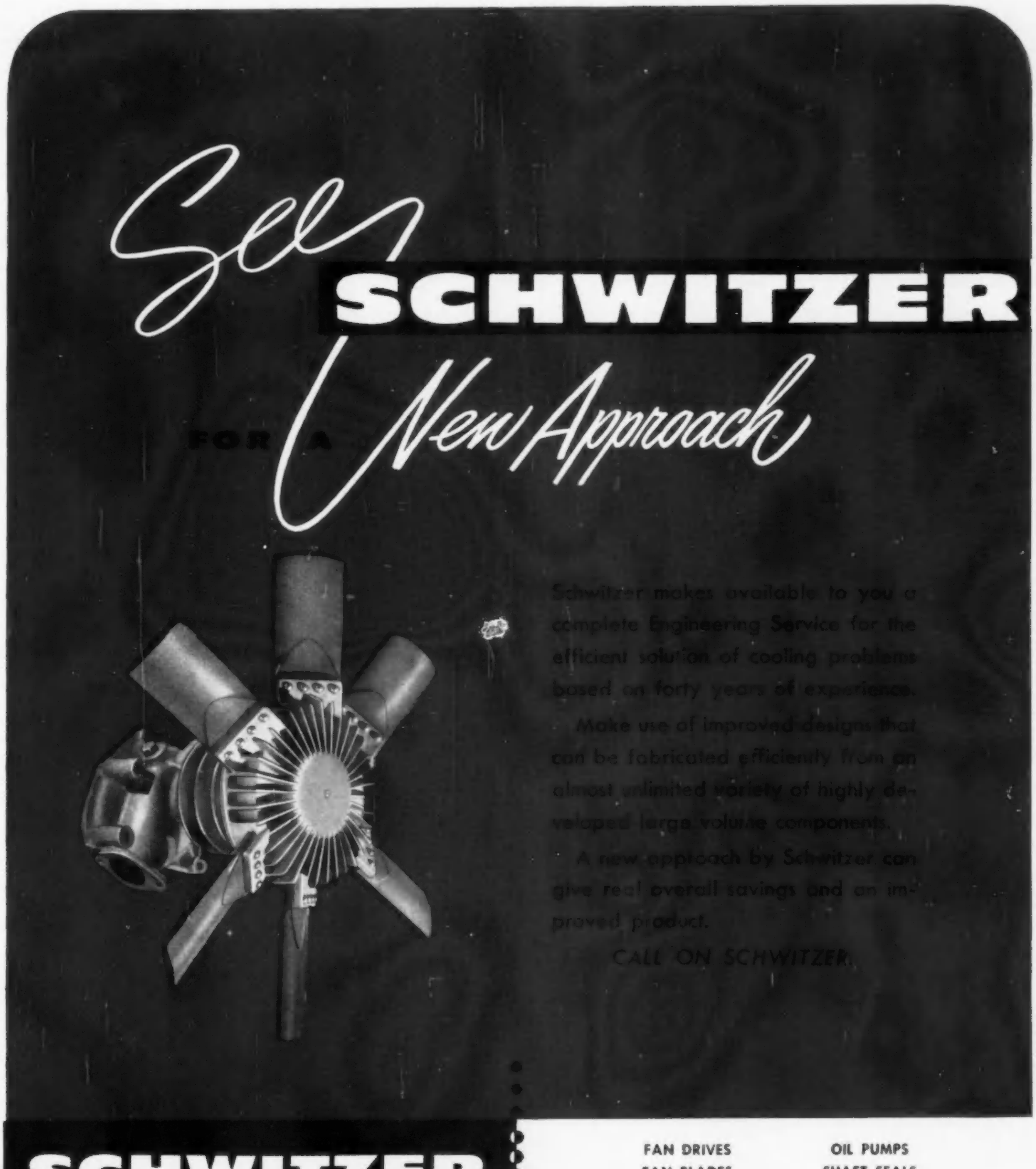
Aluminum Set-Up Blocks

Aluminum alloy multi-step set-up blocks soft enough to prevent damage to machine table finish yet strong enough to withstand heavy weights under clamping pressure hold



work from zero to three inches. The new blocks, mounted on three-inch risers, can be pyramided to any desired height. Each block and riser is interlocked by a boss and cavity. *Jergens Tool Specialty Co.*

Circle 41 on postcard for more data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NEW PRODUCTION and PLANT EQUIPMENT

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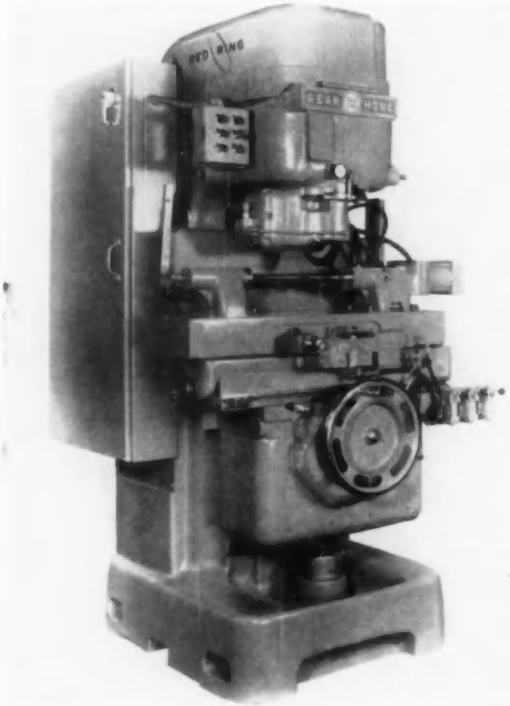
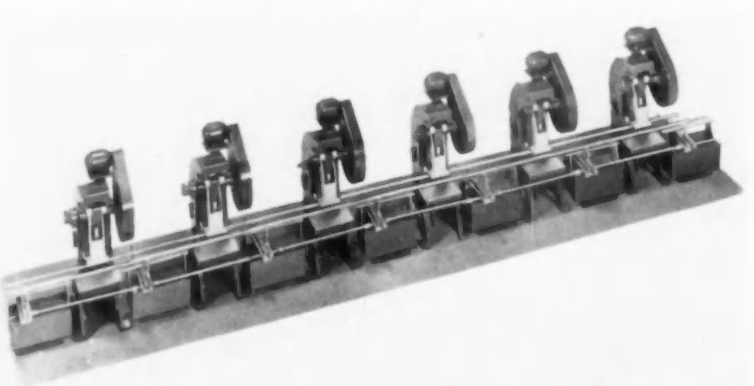
Dual Method Machine for Honing Hardened Gear Teeth



Constant-pressure and zero-backlash methods for honing hardened gear teeth are provided by an improved design gear honing machine. The headstock and air-powered tailstock are mounted on a patented tilting table that is attached to the reciprocating work table through a hinged mechanism at the rear. For removing nicks and burrs and improving surface finish of hardened gears, a constant-pressure arrangement is provided by the tilting table. When more tooth shape correction is desired the zero-backlash tilting table arrangement can be used. The Model GHB machine can be equipped for manual, semi-automatic or fully automatic loading. It is made in two sizes. (National Broach & Machine Co.)

Circle 60 on postcard for more data

Feed Mechanism for Lines of Small Presses



Clearing Transflo feed mechanism for automating lines of presses

A NEW feed actuating mechanism named Transflo Feed was designed to transfer small piece parts through a single press or through a line of up to six presses.

This feed can be used with all standard sizes of O.B.I. presses from 45 to 200 tons. It will clear a 37 in. front-to-back part dimension. Piece parts weighing up to eight lb can be handled. The feed consists of a power unit and one intermediate unit for each press in the line. Individual presses in an automated line can be dropped from automatic operation and be hand fed, while the rest of the line is operating automatically. *Clearing Machine Corp.*

Circle 61 on postcard for more data

Roll Clamp Attachment

This roll clamp attachment for a line of fork lift trucks is designed to handle paper and corrugated stock rolls up to 60 in. in diameter and 6000 lb in weight. It provides 180 deg of rotation, vertical through horizontal through vertical. (Clark Equipment Co.)

Circle 62 on postcard for more data

Twist Drill Checker

TWIST drills can be checked as to angle and centrality by use of a new drill point measuring instrument with specially hardened ways. Two vees support either a straight or tapered shank drill; and on the dial indicator, centrality is checked to 0.001 in. and angle to one degree.

It is availbale in a 1/4 to 3/4 in. size and in a 3/4 to 2 1/2 in. size. Operation requires no training and setting standards are supplied for standard drill point angles. *Engis Equipment Co.*

Circle 63 on postcard for more data

News of the MACHINERY INDUSTRIES

By Charles A. Weinert

Shipments of Machine Tools of the Metal Cutting Types During 1957 Amounted to Approximately $825 Million While New Orders Were Around $525 Million

1957 in Review

Business in the machine tool industry during 1957 was either good or relatively poor, depending upon the premise used for analysis. It was good from the standpoint of output and billings. For instance, the volume on metal cutting types — while not as yet finally compiled nor released by the National Machine Tool Builders' Association—ran in the neighborhood of $825 million. This is not as good as the corresponding figure of $886 million for 1956, but is considerably better than 1955 shipments of $670.4 million.

New Orders

The 1957 output was largely made possible by the healthy backlog of orders outstanding at the beginning of the year. Bookings during the year did not keep pace with production, and the volume of new business was disappointing to most companies. From this standpoint, the 1957 operations were not satisfactory and might be said to have been relatively poor. Here again the final figure is not yet available from NMTBA, but it would appear that the value of 1957 net new orders, for metal cutting types only, fell around $525 million. By comparison, 1956 orders amounted to $924 million, while 1955 orders totaled $927.1 million.

Expanded Facilities

The year 1957 saw only moderate expansion and consolidation in the machinery industry, when taken as a whole. This can be attributed, in general, to the fact that many expansion programs had previously been placed into effect, plus the drop-off in new business. A review of some of the happenings in the industry will give more specific information as to just what did transpire.

Early in the year, **Magnaflux Corp.**'s main plant in Chicago was enlarged by a building addition that increased assembly area by one-third—10,000 additional sq ft.

Cleveland Automatic Machine Co. and **The J. H. Day Co., Inc.**, merged, the latter becoming the **J. H. Day Co. Div.** of the parent company.

Mattison Machine Works purchased production rights to the grinders formerly built by **Mercury Engineering Corp.**

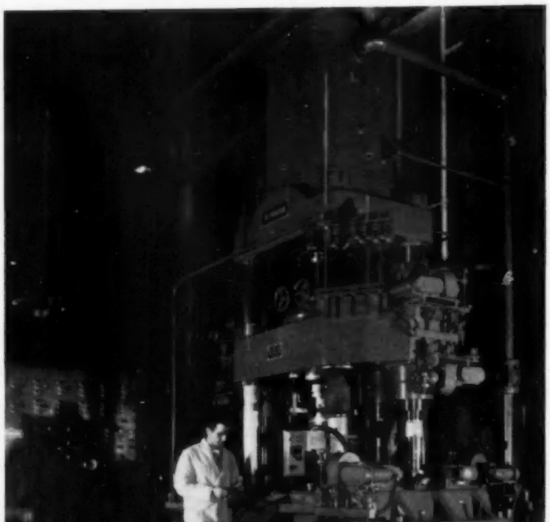
Cone Automatic Machine Co., Inc., formed a new division to handle engineering and sales for the Pilot automatic copying lathe.

Fellows Gear Shaper Co. acquired a license for the Appel cold-forming process, including the right to build machines which knead or plasticize ductile metals at relatively low temperatures—less than 150 F.

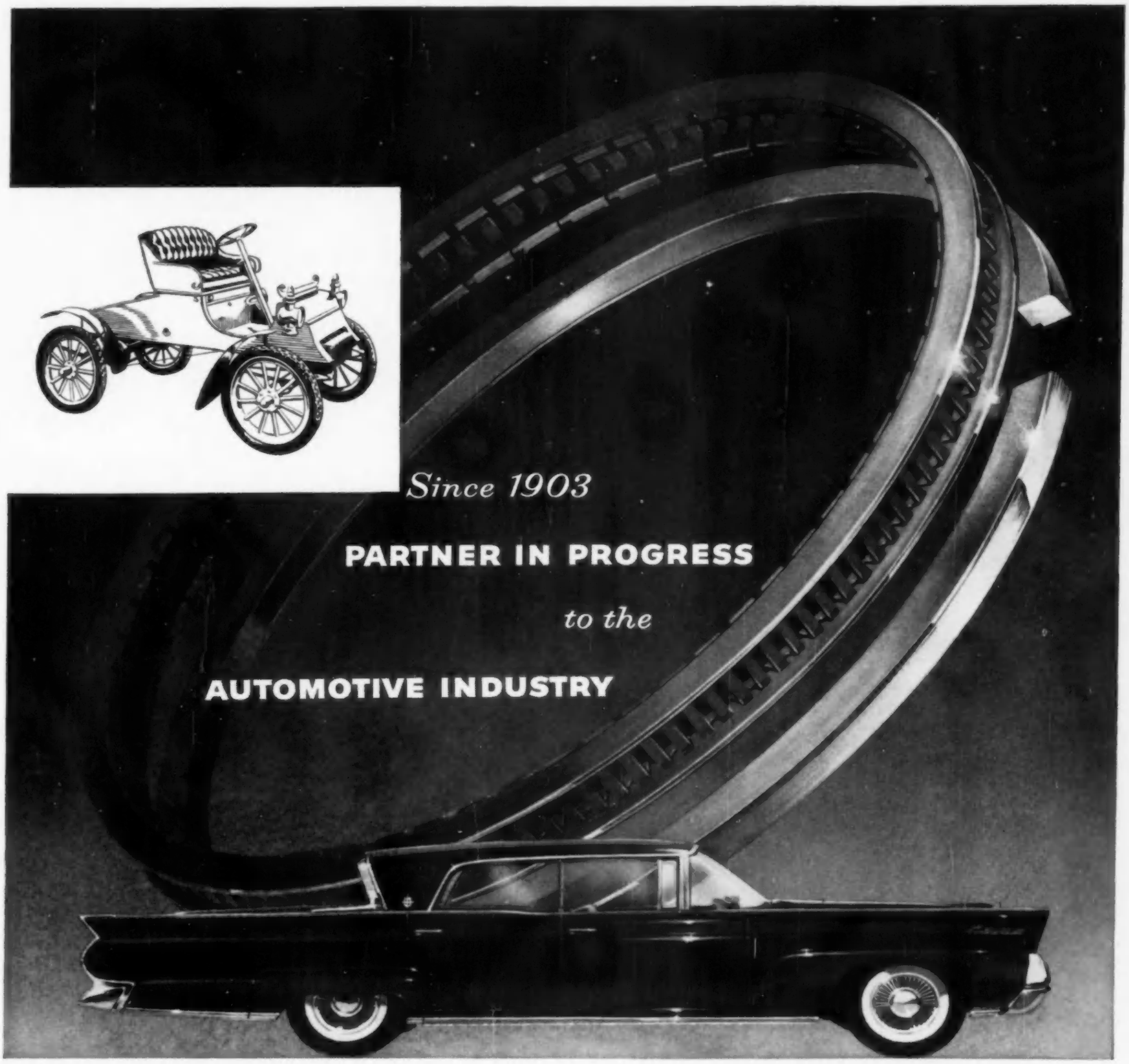
Bullard Co. bought the **Hydra-Feed Machine Tool Corp.**, moving the operation to Bridgeport, Conn.

Motch & Merryweather Machinery Co. and **Avey Drilling Machine Co.** merged, with the latter operating as a separate unit and known as **Avey Div.**

(Turn to page 125, please)



The powder metal compacting press shown is a Stokes Model 713 300-ton multiple - motion hydraulic unit that was recently formally accepted by Yale & Towne's Powdered Metal Products Div., Franklin Park, Ill., from F. J. Stokes Corp. It will be used to form pieces as large as 10 in. diam and weighing as much as eight pounds. One of the design innovations of this new series press is called proportional pressing, by which the two lower compacting punches start their upward compression strokes at different levels but arrive simultaneously at their final, full-compression level. Depth of fill and length of the compression strokes are adjusted by means of motor-driven mechanical stops, controlled from pushbutton panel.



CONTINENTAL MARK III—one of the many great motor cars equipped with Perfect Circle piston rings

Much history has been written since the early days when Perfect Circle began making parts to put horsepower into the "horseless carriage." Year after year, we have been privileged to take an active part in the development of the wonderful vehicle that is today's automobile.

One big factor in our active participation in the progress of the automotive industry is PC engineering leadership, with facilities unmatched by any other piston ring manufacturer. And PC research is a never-ending activity, forever searching for the new and the better. Out of such engineering and research have come most of the important ring achievements of the past.

Specifically engineered to meet the exacting demands of modern high-compression engines, Perfect Circle piston rings are preferred by more engine manufacturers for original equipment and for replacement service than any other brand. Perfect Circle Corporation, Hagerstown, Indiana; The Perfect Circle Co., Ltd., 888 Don Mills Road, Don Mills, Ontario.

PERFECT CIRCLE PISTON RINGS

Observations

By Joseph Geschelin

Murphy's Law

At a recent technical meeting an aircraft engineer explained the implications of Murphy's Law. If you have heard this just forget we said it. The Law applies to the complicated harness of pneumatic, hydraulic, electric, and electronic equipment so widely in use in aircraft and missiles as well as in automotive equipment. It states that if there is any way in which a complicated harness can be assembled incorrectly, any way in which connections can be wrong, any way in which the harness can be applied improperly—you can be sure that's how it will be done. The lesson taught by Murphy's Law is this—vigilance and quality control.

Purchase Policy

A recent brochure issued by Shakeproof touches on some important economic facts about the use of fastenings in motor vehicles. The discussion stems from the age-long policy of cutting the last decimal point of cost out of the per piece cost of fastenings. Shakeproof points out that in a typical case covering fastenings for an entire passenger car, the cost of the fastenings is only 19 per cent of the overall cost of the pieces plus assembly cost. This means that, on the average, 81 per cent of the cost of fastenings in the car is in labor and burden. Consequently, if one is seeking ways of reducing cost the place to look is in labor and burden at assembly. They call this approach Creative Engineering. One path in this direction is to employ pre-assembled fasteners. This saves time in handling and assures greater economy on the production line. To futher improve economy, the company has developed the Sempak, an automatic portable screw driver that can be used anywhere on the line; and a pedestal type power screw driver with controlled torque for automated assembly operations. The versatility of modern fastenings and pre-assembled fastenings complete with lockwashers is simply amazing and deserves close study.

Water Base

Water soluble paints, based on latex formulations supplied by Dow Chemical, are beginning to show mass production applications. The most notable example is found in the new Lincoln plant. Here they have the paint dip tank operation in which the entire underbody structure, up to 28-in. above the floor, is immersed in corrosion-resisting paint. With the initiation of large scale production Lincoln switched to the water-base paint. Its main advantage to Lincoln is that it is free from volatile solvents, hence is free from the hazards of fire and explosion. Moreover, protection is no longer needed against the solvent fumes.

Stainless Fabrication

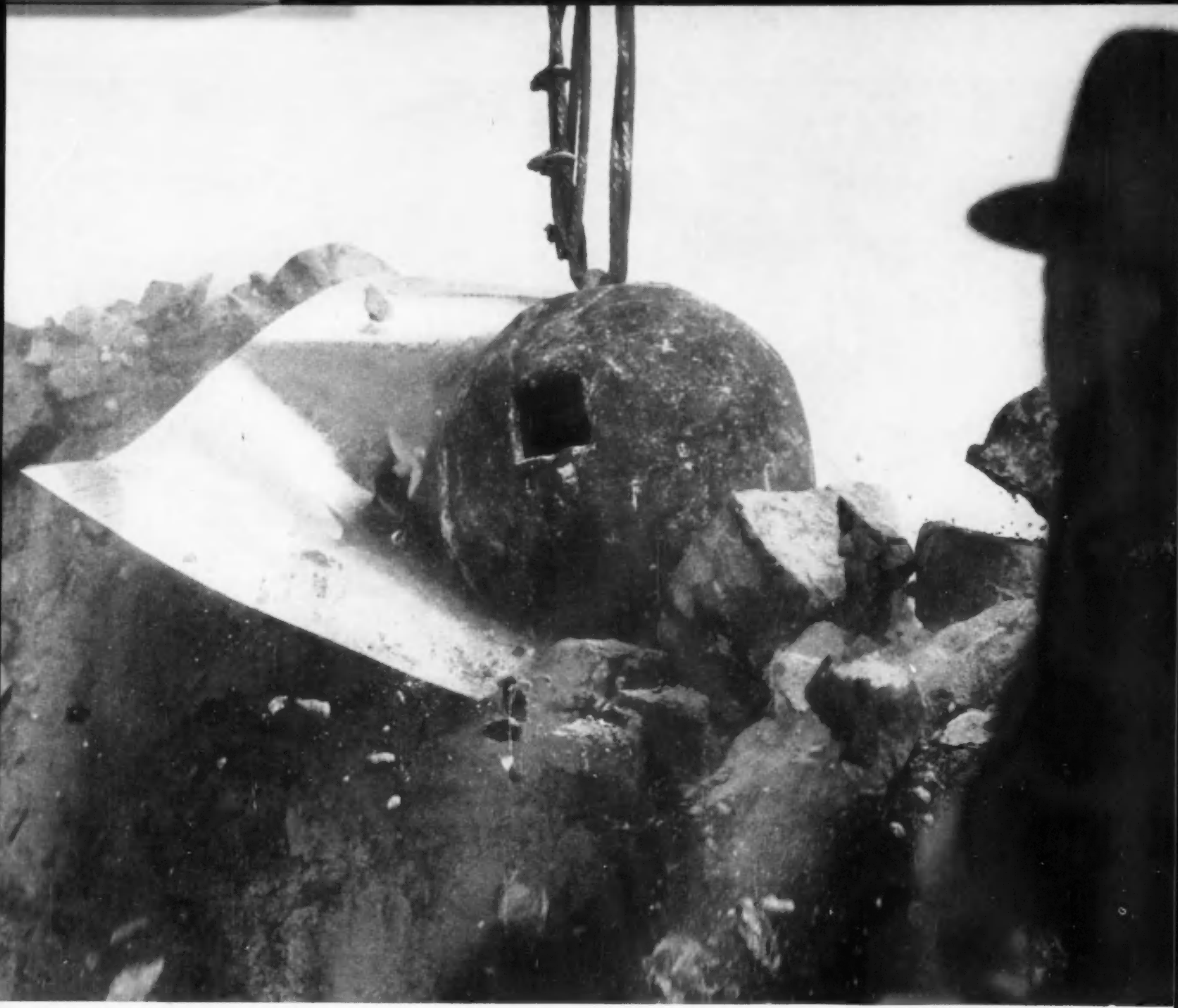
We learn that Allegheny-Ludlum is preparing a book dealing with the fabrication of stainless steels. Meanwhile, they are issuing some excerpts of interest to production people. The latest of these, dealing with the cutting and forming of stainless steels, points out that it takes more power to cut and form than is the case with carbon steel. In shearing, chromium-nickel steel stainless requires a deeper cut before it breaks apart. A shear rated for 1/4-in. steel will not handle stainless heavier than 3/16-in. Sharp, carefully ground knives are important, accurately adjusted and rigidly mounted. Blade clearance is most important to prevent strain hardening and is usually held at about five per cent of stock thickness.

Remote Control

One of our friends recently demonstrated a remote control for power steering that could well revolutionize the handling of off-highway vehicles and equipment. Briefly, it consists of a small hand control with a rotatable knob which is moved exactly as you would the steering wheel. It is connected ingeniously to the valve of the power steering gear element so that motion transmitted through a push-pull cable gives positive control. The cable can be made in any convenient length, thus making it possible for an operator to guide the machine or vehicle while walking alongside.

Small Cars

The controversy over the small, low-priced and economical cars will continue to rage for a long time to come. Or until some domestic producer enters actively in the field. Chevrolet's Ed Cole still says that we must have a market for at least 500,000 cars nationally before it could become attractive to a large manufacturer. The point is that unless mass production methods can be employed there is no chance of competing against foreign-produced small cars. Meanwhile, the industry will watch with something more than curiosity the registrations of Opel, Vauxhall, and British Fords during 1958. Sales of these cars may have an important bearing on the future course of events.



AUTOMATION NEWS REPORT

AUTOMATIC CONTROLS

PRODUCTION—VEHICLES—AIRCRAFT

By Samuel Cummings

BOOM IN ELECTRONICS

Production and dollar volume of electronic products hit new highs in 1957, says James D. Secrest, executive vice-president of Electronic Industries Association.

Factory sales rose from $5.9 billion in 1956 to more than $7 billion in the past year. For this year, Mr. Secrest says, the electronic industry expects another increase of from 8 to 10 per cent.

Military procurement of electronic products led the way, with an increase from $2.7 billion to nearly $3.5 billion. Greater emphasis on missile output and a higher defense budget, Mr. Secrest predicts, are certain to boost this figure in 1958. Research spending will also rise.

The sharp increase in military spending for electronic devices, Mr. Secrest points out, occurred in spite of pre-Sputnik defense cuts. He estimates that 23 per cent of military procurement dollars are now going to the industry, a new high. This ratio may well rise in the year ahead as missile production gathers momentum.

Although industrial uses of electronics are overshadowed by military uses, Mr. Secrest believes that the industrial field offers the greatest promise for the industry. In this area, factory sales rose from $950 million to $1.3 billion in 1957, and another rise is expected this year.

One of the most significant developments in the industrial field, Mr. Secrest reports, was the recent decision of the American Automobile Association to campaign for automatic controls on vehicles and new highways. This decision was influenced by tests that show that electronic safety devices can cut down on the number of automobile accidents. Another encouraging trend, he noted, is toward the use of electronic devices to coordinate and control traffic from a central point.

WIND TUNNEL INSTRUMENTATION

North American Aviation, Inc., has installed a unique system of instrumentation to collect and process data from its Trisonic wind tunnel.

The new system, called Datamaster, can present the information in graphic form between test runs, thus allowing engineers to plan the next test during the "pump-up" period and cutting down on test time.

Datamaster consists of two subsystems: one collects information from 144 sensing elements at the rate of 7200 points a second; the other computes these data and makes up completed charts in from 15 to 30 minutes.

The Trisonic wind tunnel can test scale models of advanced aircraft and missiles at subsonic, transsonic, and supersonic air speeds up to 2500 mph, the company says.

ELECTRONIC ROAD TESTER

Perfect Circle Corp. has developed an electronic instrument that can record the four basic engine variables—rpm, manifold pressure, and oil and water temperatures—on a single magnetic tape while a vehicle is being road tested. The tape is used to cycle a dynamometer, thus simulating road operating conditions in the laboratory.

ELECTROMATION

American factories must boost the capacity of their electrical systems before they can automate operations enough to meet the demands of a growing population, according to A. C. Monteith, Westinghouse vice-president for apparatus products. He cited a survey of 550 important industrial plants which showed that a big majority had inadequate electrical equipment to handle the power loads that are anticipated in the next 10 years.

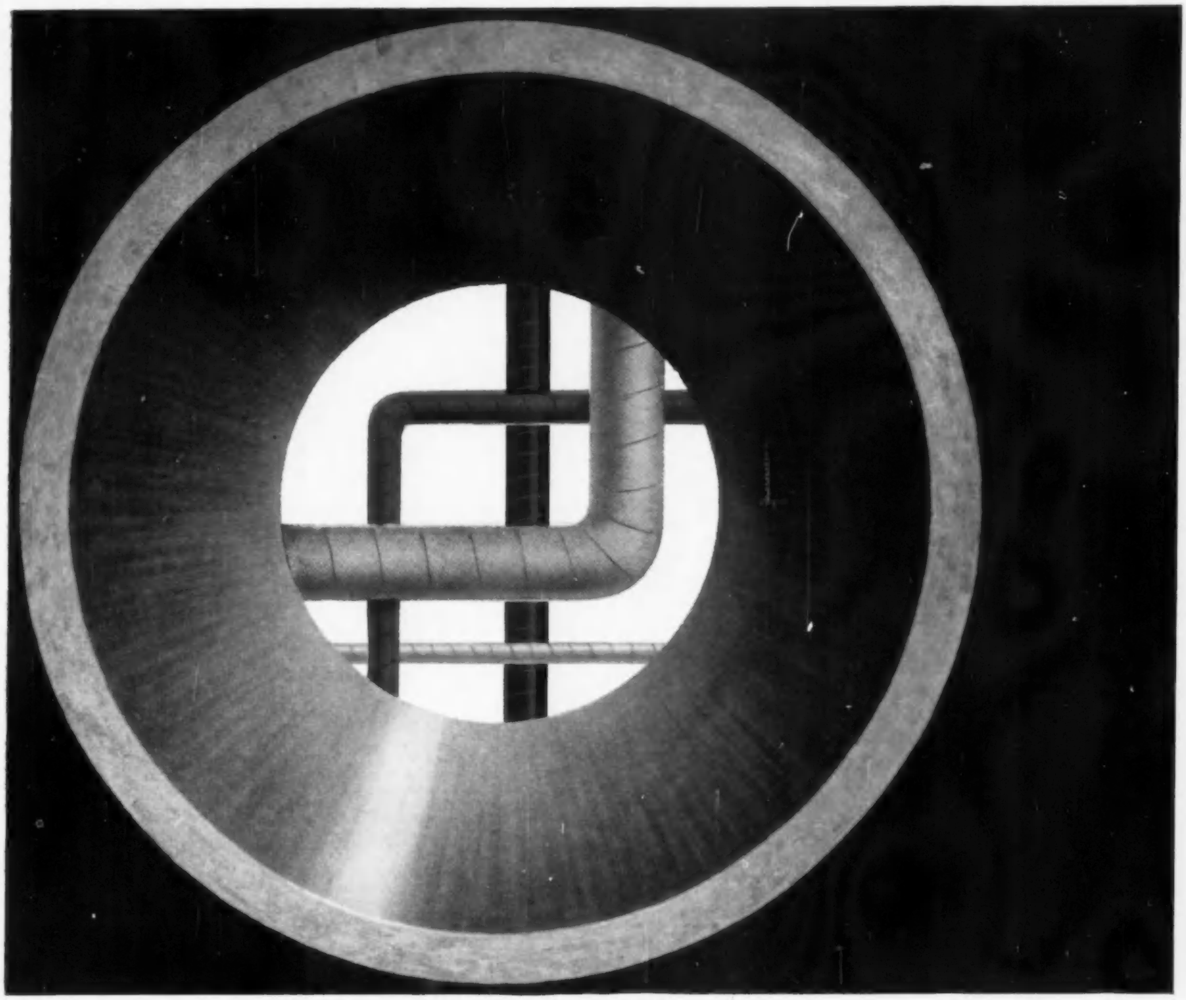
MEDIUM-PRICED COMPUTER

ElectroData Div. of Burroughs Corp. claims to have achieved a major "technical breakthrough" in the data processing field with the announcement that it will soon be ready to market the Datatron 220, a medium-priced, high-speed general purpose digital computer. First deliveries of Datatron 220 will be made in mid-1958.

The new machine is designed for use both in scientific problem solving—where speed and data manipulation are critical—and business data processing, which requires volume capacity for automatic record handling.

The Datatron 220 will make over 300,000 additions or subtractions, 30,000 multiplications, and 15,000 divisions a minute. Up to 600 million characters of information can be filed electronically in the system

(*Turn to page* 132, *please*)



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• • INDUSTRY STATISTICS • •

1957 WEEKLY U. S. MOTOR VEHICLE PRODUCTION

As reported by the Automobile Manufacturers Association

Make	Weeks Ending Dec. 14	Weeks Ending Dec. 7	Year to Date 1957	Year to Date 1956
PASSENGER CAR PRODUCTION				
Hudson	......	......	1,345	6,943
Nash	......	......	3,561	17,154
Rambler	3,383	2,923	101,457	75,274
Total—American Motors	3,383	2,923	106,363	99,371
Chrysler	2,188	2,275	115,636	101,401
De Soto	1,787	2,247	115,888	98,217
Dodge	4,991	6,117	287,134	195,166
Imperial	729	713	37,096	*
Plymouth	13,265	10,259	636,531	430,653
Total—Chrysler Corp.	22,960	21,611	1,192,285	825,437
Edsel	444	548	53,461	......
Ford	31,027	30,035	1,457,011	1,305,170
Lincoln and Continental	968	868	36,136	46,888
Mercury	5,462	5,350	267,467	233,572
Total—Ford Motor Company	37,901	36,801	1,814,075	1,585,630
Buick	11,420	10,969	388,078	512,512
Cadillac	3,371	3,336	147,152	133,022
Chevrolet	44,915	43,589	1,449,191	1,567,655
Oldsmobile	10,825	10,010	370,864	416,592
Pontiac	8,782	8,891	325,940	324,424
Total—General Motors Corp.	79,313	76,795	2,681,225	2,954,205
Packard	157	76	5,094	13,289
Studebaker	883	1,303	65,194	78,421
Total—Studebaker-Packard Corp.	1,040	1,379	70,288	91,710
Checker Cab	66	90	3,871	3,991
Total—Passenger Cars	144,663	139,599	5,868,107	5,560,344

* Included with Chrysler.

TRUCK AND BUS PRODUCTION

Make	Weeks Ending Dec. 14	Weeks Ending Dec. 7	Year to Date 1957	Year to Date 1956
Chevrolet	7,897	8,266	339,110	340,415
G. M. C.	1,505	1,480	66,563	88,466
Diamond T	141	153	5,594	4,956
Divco	60	60	2,727	3,449
Dodge and Fargo	1,634	1,642	74,767	87,735
Ford	6,094	5,998	324,626	291,915
F. W. D.	15	8	1,000	1,597
International	2,858	2,795	116,733	132,073
Mack	363	295	16,536	17,544
Studebaker	128	157	9,072	14,582
White	357	316	18,084	20,535
Willys	1,307	1,395	71,786	62,044
Other Trucks	75	75	4,010	6,161
Total—Trucks	22,434	22,640	1,050,608	1,071,472
Buses	65	55	3,744	4,077
Total—Motor Vehicles	167,162	162,234	6,922,459	6,635,893

RETAIL CAR SALES BY PRICE GROUPS*

NUMBER OF CARS

October

Price Group	1957 Units†	1957 % of Total	1956 Units†	1956 % of Total
Under $2,000	1,017	.23	17,629	4.25
$2,001 to $2,500	285,360	64.47	266,945	64.30
$2,501 to $3,500	124,440	28.11	116,545	28.07
Over $3,500	31,824	7.19	14,012	3.38
Total	442,641	100.00	415,131	100.00

Ten Months

Price Group	1957 Units†	1957 % of Total	1956 Units†	1956 % of Total
Under $2,000	23,565	.48	831,481	16.75
$2,001 to $2,500	3,102,188	63.22	2,783,870	56.09
$2,501 to $3,500	1,391,254	28.36	1,148,898	23.15
Over $3,500	389,508	7.94	198,890	4.01
Total	4,906,515	100.00	4,963,139	100.00

DOLLAR VOLUME OF SALES

October

Price Group	1957 Dollars	1957 % of Total	1956 Dollars	1956 % of Total
Under $2,000	$ 1,593,639	.14	$ 34,131,572	3.45
$2,001 to $2,500	644,056,988	55.37	578,763,860	58.50
$2,501 to $3,500	351,194,720	30.20	316,608,265	32.00
Over $3,500	166,168,179	14.29	59,826,129	6.05
Total	$1,163,013,526	100.00	$ 989,329,826	100.00

Ten Months

Price Group	1957 Dollars	1957 % of Total	1956 Dollars	1956 % of Total
Under $2,000	$ 42,017,779	.33	$1,627,679,072	14.00
$2,001 to $2,500	6,974,795,617	54.25	5,987,818,912	51.50
$2,501 to $3,500	3,928,587,983	30.56	3,159,285,849	27.17
Over $3,500	1,910,952,499	14.86	852,855,052	7.33
Total	$12,856,353,878	100.00	$11,627,638,885	100.00

*—Calculated on basis of new car registrations, as reported by R. L. Polk & Co., in conjunction with advertised delivered price at factory of four-door sedan or equivalent model. Does not include transportation charges or extra equipment.

†—New registrations of American made cars only. Does not include imported foreign cars.

NEW REGISTRATIONS OF FOREIGN CARS

First Ten Months

1957		1956	
Volkswagen	52,573	Volkswagen	41,228
Renault	18,127	Metropolitan	5,826
British Ford	13,717	M. G.	4,431
M. G.	11,613	British Ford	3,129
Metropolitan	10,187	Jaguar	3,080
All Others	60,709	All Others	20,846
Total	166,926	Total	78,540

1957 NEW REGISTRATIONS

Based on data from R. L. Polk & Co.

NEW PASSENGER CARS

Make	October 1957	September 1957	October 1956	Ten Months 1957	Ten Months 1956
Ford	117,175	121,154	109,150	1,263,160	1,119,886
Chevrolet	114,223	123,181	114,633	1,212,996	1,323,669
Plymouth	42,655	49,857	27,896	522,831	405,528
Buick	24,384	28,323	33,772	332,102	464,902
Oldsmobile	24,622	29,827	31,053	311,319	381,548
Pontiac	24,053	25,823	26,316	273,872	308,875
Mercury	19,909	21,803	19,786	232,781	239,009
Dodge	20,467	21,183	14,070	225,363	184,801
Chrysler	10,572	11,545	7,487	120,186	101,235
Cadillac	10,579	11,931	7,562	118,758	117,472
De Soto	8,375	7,901	6,609	89,911	85,614
Rambler	7,539	4,973	5,067	73,641	59,935
Studebaker	4,951	4,551	3,784	53,205	66,168
Lincoln	2,602	2,777	3,155	29,913	36,380
Edsel	8,387	7,566	......	15,873	......
Metropolitan	1,017	1,361	691	10,187	5,826
Nash	563	728	1,654	8,748	21,941
Packard	250	352	1,357	4,781	26,749
Hudson	175	269	758	4,299	10,350
Continental	20	23	66	618	1,331
Misc. Domestic	357	363	364	3,707	3,306
Foreign	21,000	19,726	9,184	156,739	72,714
Total—All Makes	463,795	495,217	424,414	5,064,990	5,037,239

NEW TRUCKS

Make	October 1957	September 1957	October 1956	Ten Months 1957	Ten Months 1956
Chevrolet	23,269	27,380	25,604	251,623	255,196
Ford	28,072	25,524	23,146	239,189	227,470
International	9,080	9,213	9,317	81,526	92,735
G. M. C.	5,105	5,275	6,297	53,060	70,471
Dodge	3,877	4,173	4,417	40,392	48,515
Willys Truck	1,377	1,166	1,346	12,544	11,405
Mack	1,265	1,072	1,196	11,332	11,219
White	1,047	898	1,260	11,039	13,078
Studebaker	440	461	469	5,736	7,658
Willys Jeep	643	555	912	5,436	7,315
Diamond T	327	240	403	2,899	3,451
Divco	231	169	257	2,264	2,737
Reo	140	143	316	1,826	2,577
Kenworth	76	149	104	916	1,131
Brockway	80	58	53	601	764
Peterbilt	38	37	85	436	539
F. W. D.	37	28	39	390	373
Misc. Domestic	84	78	131	731	1,012
Foreign	1,711	1,537	700	12,097	4,068
Total—All Makes	76,899	78,156	76,052	734,037	761,714

SOVIET INDUSTRIAL GROWTH

(Continued from page 59)

would require vast expenditures of money and time.

Offsetting these difficulties, at least in part, are new potentials realizable from the Soviet Union's total military-economic capacity. The most significant of these come from military cutbacks which should become increasingly feasible with the achievement of greater atomic abundance. In 1956, the Soviets reduced their armed forces significantly. In fact, the apparent gain in professional manpower from demobilization, about 155,000 men, approached the number of professional-level graduates (191,000) in that year. Other resource savings, especially future economies in the military consumption of steel, are likely.

To an increasing extent since 1953, the Soviets have been relieving acute deficiencies of supply through imports. In 1956, for example, shipments of heavy duty, bare copper wire from the United Kingdom alone totaled 89,356,120 lb, or nearly 14 per cent as much as the entire Soviet copper-refinery output. The development of Soviet capacity for the large-scale and relatively cheap production of some types of producers' goods, such as standard machine tools, provides a counter-balancing export capability, particularly in relation to underdeveloped countries.

Allied to a growing scale of imports is a massive Soviet program of gathering and digesting all available technical and scientific information from the West. Similar programs were conducted effectively in the 1930's and during World War II, but official xenophobia inhibited use of foreign data between 1947 and 1955. Since 1955, the program has picked up immense momentum. The Soviets are also expanding the scope and improving the quality of their statistical programs. Much attention is being paid to machine handling of data, including advanced computer procedures. Fundamental Soviet problems, such as rational approaches to prices and wages in a nonmarket economy, are being vigorously attacked. The rigid administrative structure of the Soviet economy has been shaken up. The combination of these efforts may well eventuate in a marked improvement in the efficiency of the Soviet economy and in greater returns for the immense efforts of the Soviet people.

Economic analysis must not be blind to non-economic alternatives. As the brilliant Soviet psychological exploitation of the "sputnik" has shown, scientific feats can capture the world's imagination and have major politico-economic consequences. Military coercion and the exploitation of discontent in Asia, Africa, and Latin America are other avenues to Soviet aggrandizement.

Which course or combination of courses the Soviet Union may choose is unpredictable. Nevertheless, the prospect of determined, tactically flexible pressures against the West appears quite certain.

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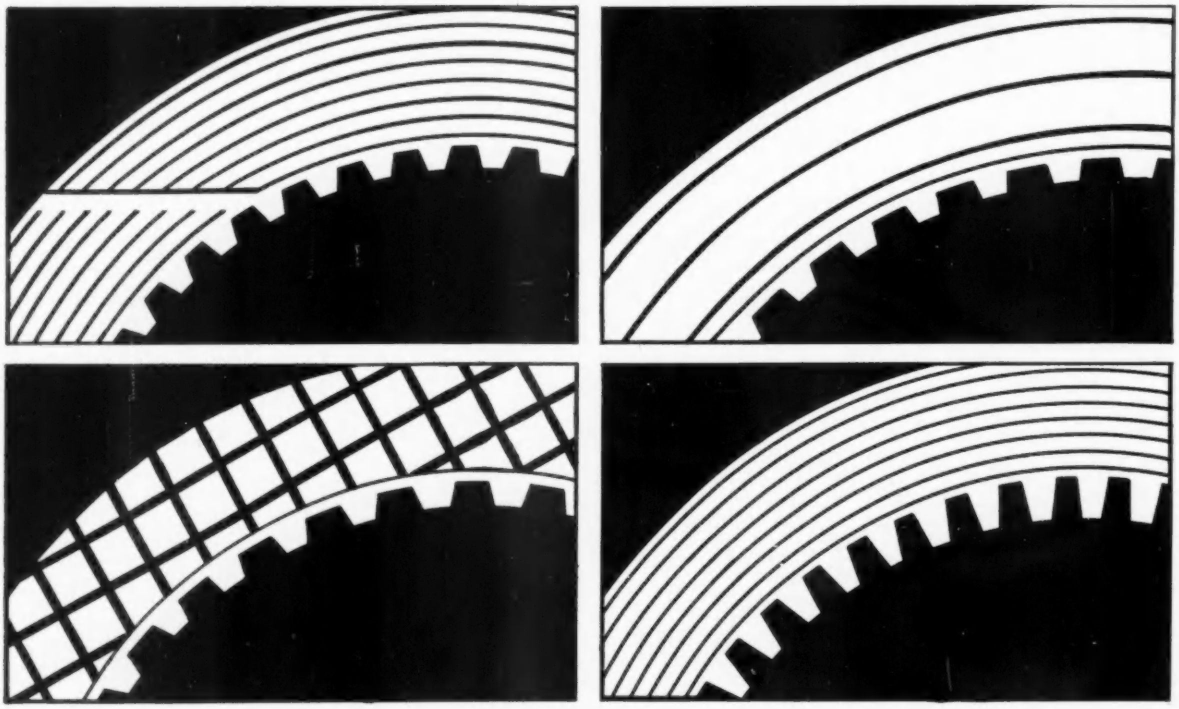

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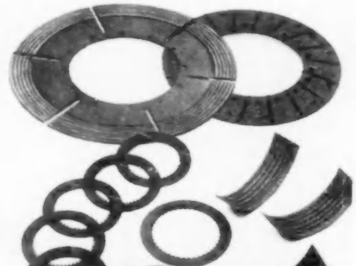

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News of the

MACHINERY INDUSTRIES

(*Continued from page* 114)

Cross Co. opened a new $6 million plant at Fraser, Mich., for the manufacture of automation machinery. The company also licensed three firms—**Scully-Jones & Co., Seibert & Sons, Inc.,** and **Royal Design & Mfg., Inc.**—to build the Cross machine control unit.

National Automatic Tool Co., Inc., enlarged plant facilities by the addition of a new 75 by 530-ft building, increasing manufacturing space by 30 per cent.

Westinghouse Electric Corp. placed into operation a highly-automated small motor plant at Upper Sandusky, Ohio, having 66,000 sq ft of floor space.

Foote-Burt Co. purchased the assets and business of the **A. P. Schraner Co.,** including patent rights covering the Schraner external cylindrical lapping machines and external roll burnishing machines.

Norton Co. announced plans for the building of a new $6.5 million plant in Worcester, Mass., for the manufacture of grinding wheels, with completion scheduled for mid-1959.

Illinois Gear & Machine Co. announced a $2 million expansion program for its South Works in Chicago. Building construction will double the size of the company's heavy manufacturing division. More than half of the expenditure was slated for new heavy machine tools.

Gardner-Denver Co. purchased the plant of **Camfield Mfg. Co.** at Grand Haven, Mich., obtaining a building with 68,000 sq ft of manufacturing space. Acquisition of a new 22,000 sq ft factory in Rio de Janeira, Brazil, to expand Gardner-Denver's manufacturing facilities there, was also announced.

The Hydraulic Press Mfg. Co., a division of **Koehring Co.,** acquired **Henry & Wright Div. of Emhart Mfg. Co.**

Cincinnati Shaper Co. formed a British subsidiary for the manufacture of metalworking machinery in Great Britain.

Sheffield Corp. acquired a major interest in **M.P.J. Gauge & Tool Co., Ltd.,** Birmingham, England, and announced plans for expansion which will eventually enable the British company to make and sell all Sheffield products in the English market.

Baldwin-Lima-Hamilton Corp. purchased from **Futurmill, Inc.,** the manufacturing rights to the Futurmill structural milling machine. Exclusive sales distribution of the machine (named the Baldwin-Futurmill) was retained by Futurmill, Inc.

Snyder Tool & Engineering Co. announced the completion of a two-step factory expansion program, involving a total expenditure of $680,000, with the addition of a new 5520 sq ft building.

Directors of **United Drill & Tool Corp.** and **Greenfield Tap & Die Corp.** approved a plan for merger of these corporations.

Industrial Engineers Discuss Tool Purchases

Several hundred industrial engineers recently attended a meeting in Chicago where machine tool acquisition planning, automation, and processing cost studies were discussed. The occasion was the Industrial Productivity Conference, held at Illinois Institute of Technology on December 5 and 6. (*Turn to page* 129, *please*)

METALS

Ingot Production for 1957 Estimated at Approximately 113 Million Tons, or About 80 Million Tons of Finished Steel

By William F. Boericke

December a Poor Month for Steel

The decline in the steel industry's operating rate which had continued for nine straight weeks by mid-December and reduced it to less than 70 per cent of capacity will make the month the lowest demand period since 1954. Users are cutting inventories and relying on the mills for quick delivery when needed. To obtain orders in the face of fierce competition, the mills are obliged to carry heavy stocks of semi-finished steel as well as large stocks of finished steel. Order backlogs are slipping fast and incoming business is running well below output in spite of cutbacks.

Nevertheless it is probably true that industry is using up more steel than is indicated by shipments. Inventory cutting continues relentlessly. There is now little doubt that inventories were sadly underestimated earlier in the year. Banking heavily on big orders from the automobile makers in the fourth quarter, the mills built up excessive amounts of semifinished steel to anticipate these orders which failed to materialize. Consumers themselves apparently overbought a year ago following the end of the steel strike and continued to add to stocks through the first half of this year.

Cutbacks in Operating Rate

Drastic measures are being taken to rectify the top-heavy supply situation. Mills are shutting down unneeded steel and iron making facilities. Workers are being laid off, or the work week is being shortened. In two months time the operating rate in the Buffalo area dropped from 100 to 63 per cent of capacity. Somewhat similar cuts were witnessed in Pittsburgh and Youngstown. Overtime is gone for steel workers and any premium prices for steel went out of the window months ago.

Inventory Cutting the Problem

How long it will take to cut inventories to a satisfactory level is a moot question. Most trade analysts think it will require most of the first quarter for the job, some estimate an even longer period. To add to the discomfort, sharp foreign competition is encountered on the eastern seaboard in several steel products, notably wire and nails.

It is now estimated that total ingot output this year will approximate about 113 million tons, or about 80 million tons of finished steel. A decline of four or five per cent is forecast for 1958 to bring output to about 109 million tons. But forecasting steel demand a year ahead is a hazardous business. Nearly all steel executives anticipate a better demand in the second half of the year.

New Capacity Index for 1958

Early in January there will be a psychological hurdle to surmount. The industry's capacity figure will be raised from 133.5 million tons per year to about 141 million. Hence it will appear that the operating rate has dropped about four percentage points when the figure is used, although actual output may remain the same. Rather obviously both the old and new figures include many millions of tons of obsolete and inefficient facilities, and no doubt many companies with modernized equipment can do as well at less than rated capacity by concentrating work at the newer plants.

Unlikely to See Price Cutting

In spite of the hard struggle for business there appears to be little likelihood of price cutting by the steel mills. The success of the industry in 1954 in maintaining prices when the operating rate averaged 71 per cent during the year carries a lot of weight. It also appears that price cutting is pretty poor business when a wage increase of four cents an hour is just ahead which directly and indirectly will increase costs about $2 a ton. Any immediate advantage in obtaining business by price cutting will be short lived as other producers would meet the cut. The announced policy of U. S. Steel that it would immediately reduce its prices to meet competition in such a situation would act as a powerful deterrent as well.

Quotas Set Up for Tin Production

Sagging metal markets have not excepted tin which slipped badly in the New York market from 93 cents to 87 cents a pound while the International Tin Council in London was paying the equivalent of 91¼ cents a pound for spot metal. But the forward position three months hence was six cents lower, reflecting doubt that the I.T.C. had sufficient funds to continue purchases at the 91¼ cent level and would either have to reduce its support price or impose export quotas upon the producing countries.

This proved to be the case. Early in December a communique was issued after a meeting with countries

METALS

supporting the I.T.C. which set up a reduction of about 28 per cent in the rate at which six producing countries have been producing tin. The decision was made because of a surplus on the international markets. It is believed the new quotas would balance demand against supply.

The immediate result of setting up lower quotas for the tim producers was a sharp recovery in price which bounced back to the $91\frac{1}{4}$-cent level in London and New York and appears likely to stay there, at least until the next meeting of the I.T.C on January 22.

Zinc Shipments Increase

Publication of the November statistics by the Zinc Institute brought no special uplift to anxious producers. Daily average production of slab was a trifle higher than in October, but domestic shipments showed a gratifying increase to 73,419 tons for the month, highest monthly total for the year. Stocks on hand November 30 showed a decrease of 3400 tons from a month earlier. Counteracting some of this was a sharp decline of nearly 10,000 tons in unfilled orders which brought the total to 21,867 tons, a low for 1957. Special High Grade business has been going better than Prime Western.

Tariff Relief Foreseen

London prices for zinc have shown steady deterioration, and in mid-December were as low as $7\frac{3}{4}$ cents a pound. This price obviously makes the present 10 cent domestic price vulnerable, as foreign zinc can be brought into this country for about 2 cents a pound to cover freight, insurance and duty. It is very likely that the domestic price would have been reduced if it were not for the belief that tariff relief will be forthcoming in January following a probable recommendation by the Tariff Commission for a higher impost. Quite possibly there has been some inventory buying by

METALS

(Continued from page 127)

consumers in anticipation of this. It is difficult to believe that the higher shipments in November all went into actual consumption.

Lead Price Cut

Lead producers were unable to maintain their 13½ cent price in effect since October, and early in December cut to 13 cents because of increasing pressure from London, where the metal fell to 8¾ cents. The 13 cent domestic price was the lowest since March, 1954. As with zinc, the spread between New York and London is considerably more than a normal differential represented by shipping costs and duty, and reluctance to reduce the domestic price further can be traced to the same feeling about imminence of a higher tariff. The latest figures on the statistical position of lead are not good. Production was substantially more than shipments to domestic consumers and stocks of the metal at the refineries were over 59,000 tons. For the first ten months of 1957 shipments declined about six per cent from the comparable period last year. With uncertain factors ahead in the lead market, most buyers are contracting for deliveries on basis of the average price prevailing for the month rather than on the present market price.

Stable Price for Nickel Foreseen

The Commerce Department eased export restrictions on some forms of nickel scrap because of a lower demand for the metal. Premium prices have all but disappeared. There is even some questioning if the present 74 cent price can be maintained in the face of slack steel business. But this appears unduly pessimistic. The price established by Inco a year ago was far below the outside market and could easily have been set at least 50 per cent higher. Hence, unlike copper, price deflation has no pinnacle from which to fall. While supplies are ample today there is no important production ahead for three years and in the interim it seem certain that any surplus will be absorbed without difficulty.

Oversupply of Aluminum Causes No Alarm

Because of the acknowledged oversupply of aluminum, there has been some slowdown in programs for increasing production capacity both in this country and in Canada. Nevertheless, the outlook for North American producers is still favorably regarded. Shipments are expected to increase about 5 to 10 per cent in 1958 over 1957. While there has been some vicious price cutting in aluminum end products by some poorly financed fabricators, there is little reason to think that the primary producers will follow suit. U. S. producers, now able easily to supply domestic needs, are setting up international sales organizations to develop export markets. This will not be all easy sailing as adequate supplies are now available in most countries and the recent appearance of Russian aluminum at prices under the market to obtain sterling exchange is causing worry abroad.

No Cutback Scheduled in World Copper Production

While a meeting was held in London early in December by representatives of Belgian Congo, Rhodesian, and Chilean copper producers from which there was hope of an agreement to curtail production, nothing developed and the copper price, which had headed up in expectation, slumped again. According to the latest statistics, world production is only five per cent larger than deliveries, and a cutback of this amount would bring supply and demand into balance, provided shipments continued at their present rate. Domestic mines appear to have done their part in curtailing output, but they cannot be expected to carry the whole load without cooperation from the other great world producers.

The producers' price, in mid-December, still held at 27 cents a pound but there was little certainty it could hold in the face of lower markets in London and a custom smelter price of 25 cents. Imports of fabricated copper products from abroad have placed the integrated producers in a difficult position. Independent fabricators must compete with these imports and are unable to pay producers the higher domestic price for the refined metal. The integrated companies, confronted with the same problem, must reduce the prices of their own fabricated products. In doing so they can hardly escape reducing the price of refined metal to their customers at the same time.

On the other hand, cost of production for all but the largest copper producers is dangerously close to the 27 cents level and any further cut might make operations unprofitable. In fact, it is undoubtedly true that many smaller mines are today operating at less than break-even rate, and continue only because the cost of shutdown and maintenance would exceed the present deficit in operating.

GM Car Finish Test Facility Will Get New Home In Miami

General Motors' automobile finish testing laboratory is moving to a new site in Miami, Fla. where more operating space and better atmospheric conditions are expected to provide more accurate test results.

The Florida Test Field measures the effect of sun, moisture and temperature on car finishes and other materials. Occasional highway dust at the present site has hampered paint exposure evaluations, according to a GM spokesman.

New mounting racks at the larger test field will enable technicians to move paint specimens around to follow the sun, giving more flexibility to exposure tests.

MACHINERY NEWS

(Continued from page 125)

Purchase Procedure

Officials of the A. O. Smith Co. described the program used by that firm in the purchase of machine tools. Under the program, each request originated by a division is coded as to the machine's purpose. This might be for model changes in a product, manufacture of a new product, normal replacement of a worn or obsolete machine, reduction of production costs, or improvement in product quality. The request is then scrutinized by a costs reduction engineer and a chief tool and process engineer; following which a divisional capital review board considers and passes on the request. Finally, the vice president of manufacturing and other home office executives go over all of the submitted requests. Here the company comptroller's forecast of funds available for capital expenditures is applied. The divisional men then are allowed to tailor their requirements to a divisional allotment.

MAPI Formula

During the conference it was announced that Machinery & Allied Products Institute will revise its formula for acquisition of equipment in order to make the formula applicable to more situations. The new formula is now being tested and should be released next spring, according to Richard R. McNabb who represented MAPI.

Automation

Edward T. Schwendemann, Inland Steel Co., urged the conference to look carefully at accounting procedures in relation to the operation itself before deciding about automation for a given application. He contended that where accounting practice lumped all overhead and distributed it over all production costs, automation might appear to promise larger savings than allocation of overhead to the particular operation would show.

General Procurement Information on Guided Missile Programs

THE following information has been assembled for firms and individuals desiring guidance in their efforts to participate in the guided missile programs of the Military Departments.

Missiles and support equipment are of such complex nature that individuals, groups or firms, whether seeking prime contracts or subcontracting work, should submit complete information regarding existing skills in engineering and/or scientific fields, production facilities and personnel.

The Department of the Army

Companies interested in the Department of the Army Guided Missile Program as a prime or subcontractor may utilize U. S. Army Ordance Corps District Offices as readily accessible points of contact, or to discuss current procurements on a prime contract basis and possible potential subcontracting sources:

Birmingham Ordnance District
2120 N. 7th Ave.
Birmingham, Ala.

Boston Ordnance District
Boston Army Base
Boston 10, Mass.

Chicago Ordnance District
209 W. Jackson Blvd.
Chicago 6, Ill.

Cincinnati Ordnance District
Swift Bldg.
230 E. 9th St.
Cincinnati 2, Ohio

Cleveland Ordnance District
Lincoln Bldg.
1367 E. 6th St.
Cleveland 14, Ohio

Detroit Ordnance District
574 E. Woodbridge
Detroit 31, Mich.

Los Angeles Ordnance District
55 S. Grand Ave.
Pasadena, Calif.

New York Ordnance District
180 Varick St.
New York 14, N. Y.

Philadelphia Ordnance District
128 N. Broad St.
Philadelphia 2, Pa.

Pittsburgh Ordnance District
200-4th Ave.
Pittsburgh 22, Pa.

Rochester Ordnance District
Sibley Tower Building
25 North St.
Rochester, N. Y.

St. Louis Ordnance District
1016 Olive St.
St. Louis 1, Mo.

San Francisco Ordnance District
1515 Clay St., P. O. Box 1829
Oakland 12, Calif.

Springfield Ordnance District
Springfield Armory
Springfield 1, Mass.

The Army presently has prime contracts with the following companies which utilize innumerable companies and organizations for subcontract work:

Western Electric Co.
New York, N. Y.
or Burlington, N. C.

Douglas Aircraft Co.
Santa Monica, Calif.

Raytheon Manufacturing Co.
Andover, Mass.

Firestone Tire and Rubber Co.
Los Angeles, Calif.

Gilfillan Bros., Inc.
Los Angeles, Calif.

Chrysler Corp., Warren, Mich.

The Martin Co., Orlando, Fla.

Utica-Bend Corp., Utica, Mich.

Emerson Electric Co.
St. Louis, Mo.

The Department of the Navy

For information on requirements of the Department of the Navy regarding missiles, write the following Small Business Specialists who will provide more specific information as to how further to proceed:

Small Business Specialist
Bureau of Aeronautics
Department of the Navy
20th and Constitution Ave., N.W
Washington 25, D. C.

Small Business Specialist
Bureau of Ordnance
Department of the Navy
18th and Constitution Ave., N.W.
Washington 25, D. C.

Work on Navy missile requirements may also be done for prime contractors having current contracts with the Navy Department. For information on such prime contractors consult "Selling to Navy Prime Contractors" which may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.—Price 30 cents. Among current Navy prime contractors in missile work are the following:

(*Turn to page* 134, *please*)

AUTOMATION
News Report

(*Continued from page* 118)

and made available in seconds for automatic computer processing.

Heart of the system is the magnetic core memory. The memory is available in units of from 2000 to 10,000 words (10 digits plus sign), in increments of 1000. Any record in the memory can be located in 10 microsec.

Typical layout of Datatron 220 includes operator's console (center), flanked by high-speed paper tape input-output system, magnetic tape system, digital computer, expandable magnetic core memory unit, and magnetic power supply.

• • •

Canada Reduces Excise Tax On Cars to 7½ Per Cent

Canada reduced the excise tax on automobiles from 10 per cent to 7½ per cent, but industry leaders consider the tax cut as only partial relief from the sales slump that has hit the Canadian automobile market.

The tax cut was effective with the government announcement last month (December). A sharp decline in sales immediately before the cut was noted as prospective customers held back, apparently expecting a more sizeable reduction.

Canadian automobile plants were operating at reduced schedules to adjust inventories. Chrysler worked only one day a week for a period in December, General Motors worked a three-day schedule, and Ford worked five days, but at reduced output.

The tax cut was expected to mean retail price reductions of from $30 to $120 per car. Soon after the government announcement, Chrysler cut prices up to $70 on some models.

UAW To Convene in Detroit To Map Plans for Negotiations

The United Auto Workers will hold a three-day convention in Detroit from Jan. 22-24 to formulate plans for upcoming contract talks with automobile manufacturers.

Negotiations probably will begin around April 1, or 60 days prior to expiration of current contracts. General Motors' current working agreement with the UAW expires May 29, while Ford and Chrysler contracts are good to June 1.

SHORTIES

More than 70 per cent of the free world's supply of boron is located in a huge deposit in the Mojave desert, 130 miles northeast of Los Angeles.

•

The U. S. Navy's air force, with nearly 10,000 operating aircraft, is the third largest military air power in the world, exceeded only by the U. S. Air Force and the Russian air forces.

•

U. S. consumption of both natural and synthetic rubber in the period between 1950 and 1956 increased 14 per cent, from 1,258,557 to 1,436,482 long tons.

•

In the USSR, school children are introduced to biology in the fourth grade, foreign languages in the fifth, physics, algebra and geometry in the sixth, chemistry in the seventh, and calculus in the tenth.

•

In 1930, railroads hauled 75 per cent of the nation's freight and 68 per cent of all passengers. Twenty-five years later, the rails had less than half of the freight business (49 per cent) and were carrying only 36 per cent of the passengers.

•

The nation's motorists spent nearly $1.5 billion for replacement passenger tires in 1957, or about $1 out of every $200 spent for consumer goods.

•

Electronic computers have become irreplaceable tools in the design of modern aircraft. Mathematical analysis of a new transport would have cost $112 million without computers, but electronic brains held this cost to $238,400.

•

An aircraft company is building a gas turbine engine weighing only 50 lb. It will be 20 in. high, with a maximum diameter of 15.5 in., and will produce 55 shaft hp plus 12 lb of jet thrust.

Missile Procurement Information

(*Continued from page* 130)

Bendix Aviation Co.
Mishawaka, South Bend, Ind.

Convair, Division of General Dynamics
Pomona, Calif.

Chance-Vought Aircraft, Inc.
Dallas, Tex.

Douglas Aircraft Co., Inc.
Santa Monica, Calif.

General Electric Co.
Schenectady, N. Y.

Lockheed Aircraft Corp.
Sunnyvale, Calif.

Philco Corp., Philadelphia, Pa.

Raytheon Manufacturing Co.
Waltham, Mass.

The Department of the Air Force

Individuals or companies desiring procurement information relative to missiles should contact the Small Business Specialist at the Air Procurement District Offices nearest their place of business, and listed as follows:

Boston Air Procurement District
Middletown Air Materiel Area
Boston Army Base
Boston, Mass.

Newark Air Procurement District
Middletown Air Materiel Area
218 Market St.
Newark, N. J.

New York Air Procurement District
Middletown Air Materiel Area
111 E. 16 St.
New York 3, N. Y.

Philadelphia Air Procurement District
Middletown Air Materiel Area
1411 Walnut St.
Philadelphia 2, Pa.

Rochester Air Procurement District
Middletown Air Materiel Area
20 Symington Place
Rochester 3, N. Y.

Chicago Air Procurement District
Oklahoma City Air Materiel Area
5555 S. Archer Ave.
Chicago 38, Ill.

Milwaukee Air Procurement District
Oklahoma City Air Materiel Area
770 N. Plankinton Ave.
Milwaukee, Wisc.

St. Louis Air Procurement District
Oklahoma City Air Materiel Area
1114 Market St.
St. Louis, Mo.

Dayton Air Procurement District
Mobile Air Materiel Area
Bldg. 70, Area "C"
Wright-Patterson Air Force Base
Dayton, Ohio

Dallas Air Procurement District
San Antonio Air Materiel Area
912 S. Ervay
Dallas 1, Tex.

Cleveland Air Procurement District
Mobile Air Materiel Area
1279 W. 3rd St.
Cleveland 13, Ohio

Detroit Air Procurement District
Mobile Air Materiel Area
W. Warren Ave. & Lonyo Blvd.
Detroit 32, Mich.

Indianapolis Air Procurement District
Mobile Air Materiel Area
54 Monument Circle
Indianapolis 6, Ind.

Arizona Air Procurement District
San Bernardino Air Materiel Area
P.O. Box 5555, Helen St. Annex
Tucson, Ariz.

Los Angeles Air Procurement District
San Bernardino Air Materiel Area
1206 Maple Ave.
Los Angeles 15, Calif.

San Diego Air Procurement District
San Bernardino Air Materiel Area
4325 Pacific Highway
San Diego 10, Calif.

Atlanta Air Procurement District
Warner Robins Air Materiel Area
41 Exchange Place, S.E.
Atlanta, Ga.

San Francisco Air Procurement District
Sacramento Air Materiel Area
Bldg. 1, Oakland Army Terminal
W. Grand Ave. & Maritime
Oakland 14, Calif.

The following companies have prime contracts with the Air Force in the missile field:

Boeing Aircraft Corp., Box 3707
Seattle 24, Wash.

Convair, Division of General Dynamics
3165 Pacific Highway,
San Diego 12, Calif.

Douglas Aircraft Corp., Inc.
3000 Ocean Park, Santa Monica, Calif.

Lockheed Aircraft Corp.
2555 North Hollywood Way,
Burbank, Calif.

The Martin Co., Baltimore 3, Md.
North American Aviation, Inc.
Los Angeles 45, Calif.

Ideas and/or inventions which are believed to have Air Force application to missiles may be submitted for evaluation to:

Office of Technical and
Industrial Relations
Air Research and
Development Command
Box 1395
Baltimore 3, Md.
Attn: Inventions Evaluation Branch

ON OUR WASHINGTON WIRE

Leading scientists are getting behind a plan to award a $500 scholarship to every high school senior who passes a Federal mathematics test, and another $500 to every college student who passes a calculus test at the end of his freshman year. Bills to carry this plan out are pending in Congress.

Senator Majority Leader Lyndon Johnson is urging fast Government action in these three areas as a start toward regaining the U. S. scientific lead: (1) Create a centralized Federal missile authority; (2) Utilize fully the scientific talents of retired persons; (3) Set up a U. S. "space academy" to teach advanced physics.

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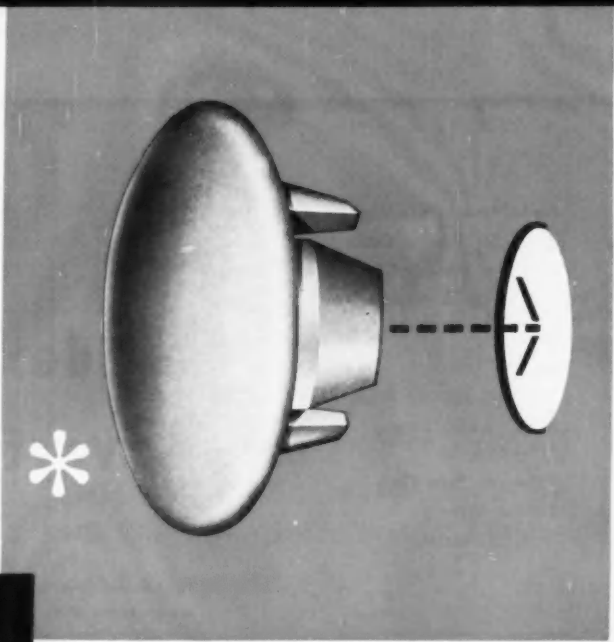

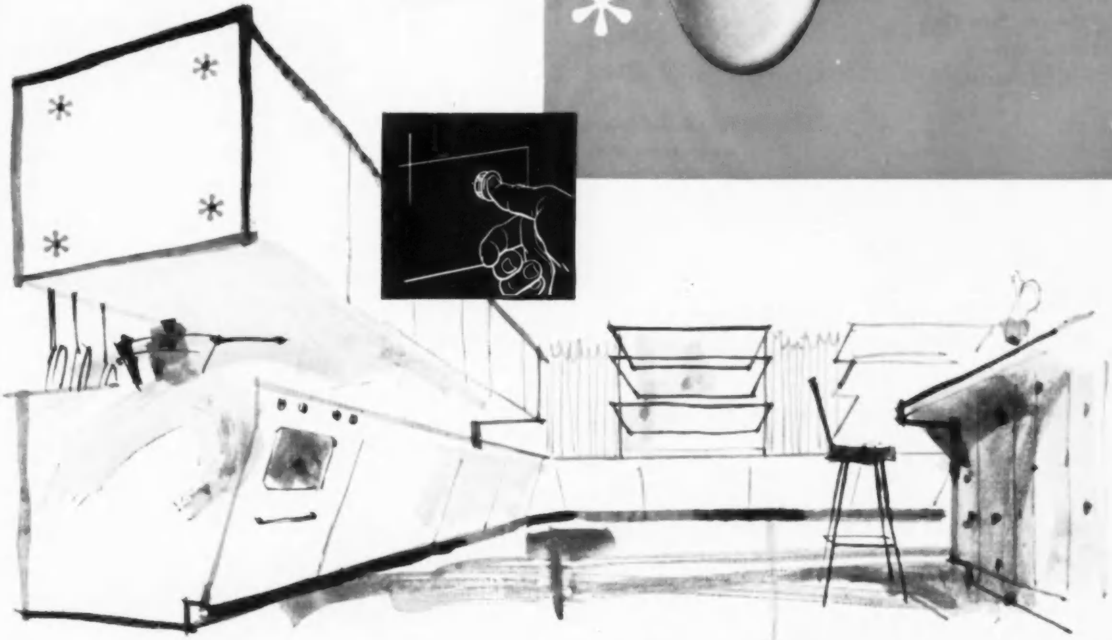

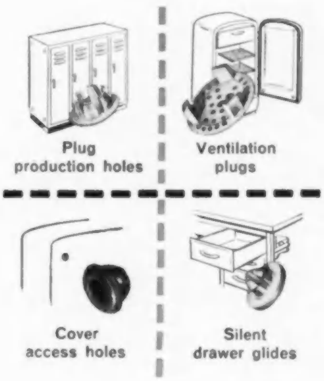

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Portrait by Fabian Bachrach

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